



Farmercoin Smart Robotic Solutions
(OPC) Pvt Ltd.
Start-up street, 1st Floor,
R H Kulkarni Building
KLE technological University.
Vidyanagar, Hubli.
580031

CERTIFICATE

This is to certify that **Mr Junaid Ahmed USN: 01FE15BAR020** student of **Bachelor of Engineering, KLE Technological University, Hubballi** has successfully completed his Internship training on **Data Analysis** in our organization from **1st February 2022 to 31st May 2022**.

He took keen interest in the work assigned to him. His conduct and behavior was found good.

We wish him all success in his future endeavors.

Date: 31st May 2022

Name:

Name:

Signature:

Signature:

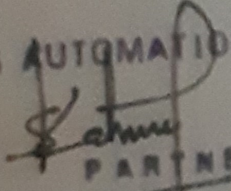
(Mentor)

(Head of Organization)

CERTIFICATE OF INTERNSHIP

This is to certify that **Mr. NAKUL SINGH HAJERI**, student of 8th Semester, department of Automation and Robotics, **KLE Technological University Hubballi**, bearing Reg No **01FE17BAR033**, has successfully completed Internship project on **"WAREHOUSE MANAGEMENT USING RFID TAGS"**, from 10th January 2022 - 31st may 2022, as part of the internship training, he has been placed in the Design and Development team and involved in relative activity of the project. During the internship with us he was found punctual, hardworking and inquisitive.

For NEX-G AUTOMATION LLP


PARTNER.

Authorised Signature

Creintors Automation Solutions Pvt.Ltd.

An Integrated Management System Certified Company
(Aligned with ISO 9001, 14001, 27001 and 45001)

Ref No: CASPL/IL/06/06/2022



Date:03/06/2022

TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr. Amogh Sutar, USN : 01FE18BAR005, Studying in IVth Year BE in Automation & Robotics from KLE Technological University, Hubli-580031. He has Successfully completed his Internship Training under the guidance of Mrs. Disha Chougule, Assistant Manager Software, on "Programming, Control & Communication in Industrial Automation Systems" and also completed the project on Automation of Vertical Storage System, at Creintors Automation Solutions Pvt Ltd, Waghawade Road, Waghawade- Belgaum-590018 from 17th January 2022 to 03rd June 2022.

During the period of his internship with us, we found him sincere, hardworking and a quick learner.

We wish him all the best in his future endeavor.

With Regards

For Creintors Automation Solutions Pvt. Ltd.

Authorised Signatory



Plot No-2, Survey No. 22/3, Waghawade Road, Waghawade, Belgaum 590018 Karnataka, India.

Mob: +91 77950 00801 | E-mail: sales@cautomate.com | Website: www.cautomate.com

CIN No. U29266KA2017PTC101599

CIN: U29304KA2017PTC106542

GSTIN: 29AAFNC7862H1ZY

Date: June 3, 2022

To

Name: Haripriya Jagadeesh

Designation: Robotics Intern

Nymble Labs Private Limited, Bangalore

Subject: Experience and Relieving Letter

Dear Haripriya,

This is to hereby confirm that you were an employee of Nymble Labs Private Limited from January 17, 2022, to May 31, 2022. This is also to confirm that your designation at the time of being relieved from the services of Nymble Labs Private Limited was 'Robotics Intern' and you were involved in designing and developing electromechanical systems, including PCBs & mechanical testing jigs and other associated duties.

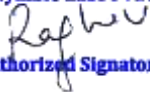
We would like to place on record the high levels of professionalism, sincerity, and dedication displayed by you over the duration of your association with Nymble Labs Private Limited and believe that you shall be a value addition to whichever organization you decide to join in the future.

Further to this, we would also like to remind you about the terms of the Internship Agreement signed by you. You shall continue to be bound by all terms of the agreement for the specified period post termination of your employment, including the conditions of confidentiality and other relevant terms.

We would also hereby like to put on record that your termination from employment has been processed subject to your resignation request. As per your request, you have been relieved from your duties effective immediately. We also confirm that all your dues and final settlement has been cleared.

We wish you the very best for all your future endeavors and projects!

For and on behalf of Nymble Labs Private Limited

For Nymble Labs Pvt. Ltd.

Authorized Signatory

Raghav Gupta
Chief Executive Officer
Nymble Labs Private Limited

L&T-TS HR/99007682

18 May 2022

Mr.Malhar Kulkarni

INTERNSHIP CERTIFICATE

This has reference to your Completion of Internship under Genesis Programme in L&T Technology Services Limited (LTTS).

Relevant details of internship during the tenure with LTTS are as under.

INTERNSHIP ID : 99007682
INTERNSHIP START DATE : 1 February 2022
INTERNSHIP END DATE : 13 May 2022
LOCATION : Mysore

We wish you success in your future endeavours.

Yours Sincerely,
For L&T Technology Services Limited,



Ashwin J
Senior Manager – HR Employee Relations & Compliance

26 May 2022

CERTIFICATE

This is to certify that Miss Phalguni Puranik (USN No. 01FEI8BAR050) a student of VIII Semester, BE Automation and Robotics from KLE Technological University,Hubballi has successfully completed her in-plant training/project in our organization during 07.02.2022 to 26.05.2022 on the topic of the project is "Auto grinding and finishing".

We wish all the best for her future endeavors.

For Kirloskar Ferrous Industries Limited



Santibhusan Das

Senior Manager-Training & Development

Creintors Automation Solutions Pvt.Ltd.

An Integrated Management System Certified Company
(Aligned with ISO 9001, 14001, 27001 and 45001)

Ref No: CASPL/L/09/06/2022



TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr. Siddhant Havalad, USN : 01FE18BAR053, Studying In IVth Year BE In Automation & Robotics from KLE Technological University, Hubli-580031. He has Successfully completed his Internship Training under the guidance of Mrs. Disha Chougule, Assistant Manager Software, on "Programming, Control & Communication in Industrial Automation Systems" and also completed the project on Automation of Vertical Storage System, at Creintors Automation Solutions Pvt Ltd, Waghawade Road, Waghawade- Belgaum-590018 from 17th January 2022 to 03rd June 2022.

During the period of his internship with us, we found him sincere, hardworking and a quick learner.

We wish him all the best in his future endeavor.

With Regards

For Creintors Automation Solutions Pvt. Ltd.

Authorised Signatory



Plot No-2, Survey No. 22/3, Waghawade Road, Waghawade, Belgaum 590018 Karnataka, India.

Mob: +91 77950 00801 | E-mail: sales@cautomate.com | Website: www.cautomate.com

CIN No. U29266KA2017PTC101599



TANTRA AUTOMATIONS

C-14, 7th Cross, KSSIDC Ind. Area, Gamangatti, HUBBALLI-580 025
Telefax : 0836 - 2207276 E-mail : tantraautomations@gmail.com

Date: 26.05-2022

INTERNSHIP CERTIFICATE

This is to certify that Mr/Mrs. MUHAMMED ALQAMAH HUILGOL
has successfully completed an internship in the field of _____
INDUSTRIAL AUTOMATIONS
From 10-01-2022 to 10-05-2022 under the guidance of VINAYAK.H.TALWAR.

During the period of her/ his internship program with us, she/he had been exposed to different processes and was found diligent, hardworking and inquisitive.

We wish her/ him every success in her/his life and career.



Your Sincerely

For Tantra Automations

L&T-TS HR/99007612

18 May 2022

Mr.Abdul Haq Indikar

INTERNSHIP CERTIFICATE

This has reference to your Completion of Internship under Genesis Programme in L&T Technology Services Limited (LTTS).

Relevant details of internship during the tenure with LTTS are as under.

INTERNSHIP ID : 99007612
INTERNSHIP START DATE : 1 February 2022
INTERNSHIP END DATE : 13 May 2022
LOCATION : Mysore

We wish you success in your future endeavours.

Yours Sincerely,
For L&T Technology Services Limited,



Ashwin J
Senior Manager – HR Employee Relations & Compliance

L&T-TS HR/99007621

18 May 2022

Mr.K A AMIRA SOHAIL

INTERNSHIP CERTIFICATE

This has reference to your Completion of Internship under Genesis Programme in L&T Technology Services Limited (LTTS).

Relevant details of internship during the tenure with LTTS are as under.

INTERNSHIP ID : 99007621
INTERNSHIP START DATE : 1 February 2022
INTERNSHIP END DATE : 13 May 2022
LOCATION : Mysore

We wish you success in your future endeavours.

Yours Sincerely,
For L&T Technology Services Limited,



Ashwin J
Senior Manager – HR Employee Relations & Compliance

L&T-TS HR/99007622

18 May 2022

Mr.ASHWIN CHANDAPUR

INTERNSHIP CERTIFICATE

This has reference to your Completion of Internship under Genesis Programme in L&T Technology Services Limited (LTTS).

Relevant details of internship during the tenure with LTTS are as under.

INTERNSHIP ID : 99007622
INTERNSHIP START DATE : 1 February 2022
INTERNSHIP END DATE : 13 May 2022
LOCATION : Mysore

We wish you success in your future endeavours.

Yours Sincerely,
For L&T Technology Services Limited,



Ashwin J
Senior Manager – HR Employee Relations & Compliance

Department of Automation & Robotics
Structure of Board of Studies 2021-22, 05th June 2021

S. No.	Category	Nomination of the Committee		Name of the Person	Signature
1	Concerned Head of the Department/ School/ Center	Chairperson	1	Arunkumar C Giriyaapur	Present
2	ONE Professor, ONE Associate Professor and ONE Assistant Professor from the Department/ School/ Center, nominated by the Dean Academic Affairs	Members	1	Dr. Jyoti Bali	Present
			2	Dr. Vinod Kumar V Meti	Present
			3	Dr. Sachin Karadgi	Present
			4	Mr. Nagaraj.M.B	Present
3	ONE PG Coordinator for each of the PG programmes offered by the Department/ School/ Center	Member(s)	1	NILL	
			2	NILL	
3	TWO Subject experts from outside the college nominated by the Vice-Chancellor	Members	1	Dr. Dhanesh Manik, IIT Bombay.	Present
4	TWO representative from industry corporate sector/ allied area relating to placement nominated by the Vice-Chancellor	Members	1	Mr. Jitendra Kataria, Beckhoff Automation India Ltd.Pune	Present
			2	Dr. Abhijit Lele, Robert Bosch India	Present
5	ONE Post-graduate meritorious alumnus nominated by the Vice-Chancellor	Member	1	Mr. Supreet Kamatagi	Present
6	ONE Student Member representing each of the program offered by the Department/ School/ Center	Invited Member	1	UG Student (Not Applicable at present)	
			2	PG Student (Not Applicable at present)	
			3	PhD Student (Not Applicable at present)	

The concerned Chairman of Board of Studies may invite additional experts to the Departmental Board of Studies as deemed fit.

A Departmental Board of Studies shall:

Meet at least once a year, sufficiently before the commencement;

Prepare detailed curricula and syllabi of concerned Programmes and submit to the Academic Council for approval and publication; and

Revise the curricula and syllabi from time to time and submit to the Academic Council for approval and publication

Structure of Board of Studies 2021-22, 05th June 2021

Sl. No	Members, BOS	Signature
1	Prof. A. C. Giriapur, Chairperson, HOD, A & R Dept.	PRESENT
2	Dr. Dhanesh Manik, IIT Bombay.	PRESENT
3	Mr. Abhijit Lele, Robert Bosch India.	ABSENT
4	Mr. Jitendra Kataria, Beckhoff Automation India . Ltd. Pune	PRESENT
5	Mr. Supreet Kamatagi, Griffyn Robotech Pvt. Ltd.	PRESENT
6	Dr. Jyoti Bali, A & R Dept.	PRESENT
7	Dr. Vinod Kumar V Meti, A & R Dept.	PRESENT
8	Dr. Sachin Karadgi, A & R Dept.	PRESENT
9	Mr. Nagaraj M B, A & R Dept.	PRESENT

Title: Curriculum Structure-Overall
 Program: B.E

Total Program Credit:178(134+44)

Page 1 of 1

Year: 2020-24

Courses Semester wise	III	IV	V	VI	VII	VIII		
	Statistics And Integral Transforms 15EMAB201 (4-0-0)	Numerical methods and partial differential equations 15EMAB206	Machine Learning & ROS 18EARC301 (3-0-0)	Hydraulics & Pneumatics 18EARC308 (4-0-0)	Industrial Data Networks 16EARC401 (4-0-0)	Professional Elective -6 XXEAREXXX (3-0-0)	Internship- Training 17EARI493 (0-0-6)	
	CALCULUS AND INTEGRAL TRANSFORMS (4-0-0)	Vector calculus and differential equations 15EMAB241 (4-0-0)						
	Analog & Digital Electronic circuits 18EARC201 (4-0-0)	Machine Design 18EARC206 (3-0-0)	Programming Industrial Automation Systems 18EARC302 (4-0-0)	Professional Elective -1 XXEAREXXX (3-0-0)	Professional Elective -3 XXEAREXXX (3-0-0)	Open Elective (3-0-0)		
	Kinematics Of Machinery 19EARC202 (4-0-0)	Control Systems 19EARC207 (4-0-0)	Real time Embedded Systems 18EARC304 (4-0-0)	Professional Elective -2 XXEAREXXX (3-0-0)	Professional Elective -4 XXEAREXXX (3-0-0)	Capstone Project 19EARW402 Industry Internship –Project 17EARW494 (0-0-11)		
	Data Structure Algorithm Design and Analysis 18EARC203 (4-1-0)	Microcontrollers Programming & Interfacing 18EARC208 (4-0-0)	Mechatronics System Design 18EARC304 (4-0-0)	Hydraulics And Pneumatics Lab 16EARP302 (0-0-1)	Professional Elective -5 XXEAREXXX (3-0-0)			
	Mechanics Of Materials 18EARC204 (3-0-0)	Object Oriented Programming & DBMS 19EARC209 (4-0-0)	Measurement Systems 18EARC305 (3-0-0)	Mechatronics & Measurements Lab 18EARP304 (0-0-1)	Senior Design Project 19EARW401 (0-0-6)			
	Manufacturing Technology 18EARC205 (3-0-0)	Robot Analysis & Design 18EARC210 (4-0-0)	Machine Learning & ROS Lab 18EARP301 (0-0-1)	Real Time Embedded Systems Lab 16EARP307 (0-0-1)	CIPE 15EHSN401 (0-0-0)			
	Analog & Digital electronics lab 18EARP201 (0-0-1)	Manufacturing & Metrology lab 16EARP205 (0-0-1)	Programming Industrial Automation Systems Lab 18EARP302 (0-0-1)	PA & LR 16EHSC301 (3-0-0)				
	Kinematics Of Machinery lab 18EARP202 (0-0-1)	Microcontrollers Programming & Interfacing Lab 18EARP208 (0-0-1)	Industrial Robotics Lab 18EARP303 (0-0-1)	Minor Project 17EARW302 (0-0-6)				
Machine Drawing Lab 19EARP203 (0-0-1)	Object Oriented Programming & DBMS Lab 19EARP209 (0-0-1)	Mini Project 18EARW301 (0-0-3)						
Credits	26	26	24	22	19	17		


 Program Head



Title: Curriculum Structure-Overall
Program: B.E

Total Program Credit:178(134+44)

Professional Elective – 3,4-,5, and 6		
Automation	Informatics & Control	Robotics
Design of automatic machinery 17EARE402	AI for Autonomous Robots 17EARE301	Mobile robotics & Perception 17EARE401
Power electronics, motors and drives 16EARE301	Advanced Microcontroller 17EARE403	
Digital System Design & FPGA Programming 17EARE304	Computer Vision & Digital Image Processing 15EARE302	
	Smart Manufacturing 17EARE404	

Title: Curriculum Structure-Overall
Program: B.E

Total Program Credit:178(134+44)

Page 1 of 1

Year: 2019-23

Courses Semester wise	III	IV	V	VI	VII	VIII		
	Statistics And Integral Transforms 15EMAB201 (4-0-0)	Numerical methods and partial differential equations 15EMAB206	Machine Learning & ROS 18EARC301 (3-0-0)	Hydraulics & Pneumatics 18EARC308 (4-0-0)	Industrial Data Networks 16EARC401 (4-0-0)	Professional Elective -6 XXEAREXXX (3-0-0)	Internship- Training 17EARI493 (0-0-6)	
	CALCULUS AND INTEGRAL TRANSFORMS (4-0-0)	Vector calculus and differential equations 15EMAB241 (4-0-0)						
	Analog & Digital Electronic circuits 18EARC201 (4-0-0)	Machine Design 18EARC206 (3-0-0)	Programming Industrial Automation Systems 18EARC302 (4-0-0)	Professional Elective -1 XXEAREXXX (3-0-0)	Professional Elective -3 XXEAREXXX (3-0-0)	Open Elective (3-0-0)		
	Kinematics Of Machinery 19EARC202 (4-0-0)	Control Systems 19EARC207 (4-0-0)	Real time Embedded Systems 18EARC304 (4-0-0)	Professional Elective -2 XXEAREXXX (3-0-0)	Professional Elective -4 XXEAREXXX (3-0-0)	Capstone Project 19EARW402 Industry Internship –Project 17EARW494 (0-0-11)		
	Data Structure Algorithm Design and Analysis 18EARC203 (4-1-0)	Microcontrollers Programming & Interfacing 18EARC208 (4-0-0)	Mechatronics System Design 18EARC304 (4-0-0)	Hydraulics And Pneumatics Lab 16EARP302 (0-0-1)	Professional Elective -5 XXEAREXXX (3-0-0)			
	Mechanics Of Materials 18EARC204 (3-0-0)	Object Oriented Programming & DBMS 19EARC209 (4-0-0)	Measurement Systems 18EARC305 (3-0-0)	Mechatronics & Measurements Lab 18EARP304 (0-0-1)	Senior Design Project 19EARW401 (0-0-6)			
	Manufacturing Technology 18EARC205 (3-0-0)	Robot Analysis & Design 18EARC210 (4-0-0)	Machine Learning & ROS Lab 18EARP301 (0-0-1)	Real Time Embedded Systems Lab 16EARP307 (0-0-1)	CIPE 15EHSN401 (0-0-0)			
	Analog & Digital electronics lab 18EARP201 (0-0-1)	Manufacturing & Metrology lab 16EARP205 (0-0-1)	Programming Industrial Automation Systems Lab 18EARP302 (0-0-1)	PA & LR 16EHSC301 (3-0-0)				
	Kinematics Of Machinery lab 18EARP202 (0-0-1)	Microcontrollers Programming & Interfacing Lab 18EARP208 (0-0-1)	Industrial Robotics Lab 18EARP303 (0-0-1)	Minor Project 17EARW302 (0-0-6)				
Machine Drawing Lab 18EARP203 (0-0-1)	Object Oriented Programming & DBMS Lab 19EARP209 (0-0-1)	Mini Project 17EARW301 (0-0-3)						
Credits	26	26	24	22	19	17		


 Program Head



Title: Curriculum Structure-Overall
Program: B.E

Total Program Credit:178(134+44)

Page 1 of 1

Year: 2019-23

Professional Elective – 3,4,-5, and 6		
Automation	Informatics & Control	Robotics
Design of automatic machinery 17EARE402	AI for Autonomous Robots 17EARE301	Mobile robotics & Perception 17EARE401
Power electronics, motors and drives 16EARE301	Advanced Microcontroller 17EARE403	
Digital System Design & FPGA Programming 17EARE304	Computer Vision & Digital Image Processing 15EARE302	
	Smart Manufacturing 17EARE404	

Title: Curriculum Structure-Overall
Program: B.E

Total Program Credit:178(134+44)

Courses Semester wise	III	IV	V	VI	VII	VIII		
	Statistics And Integral Transforms 15EMAB201 (4-0-0)	Numerical methods and partial differential equations 15EMAB206	Machine Learning & ROS 18EARC301 (3-0-0)	Hydraulics & Pneumatics 18EARC308 (4-0-0)	Industrial Data Networks 16EARC401 (4-0-0)	Professional Elective -6 XXEAREXXX (3-0-0)	Internship- Training 17EARI493 (0-0-6)	
	CALCULUS AND INTEGRAL TRANSFORMS (4-0-0)	Vector calculus and differential equations 15EMAB241 (4-0-0)						
	Analog & Digital Electronic circuits 18EARC201 (4-0-0)	Machine Design 18EARC206 (3-0-0)	Programming Industrial Automation Systems 18EARC302 (4-0-0)	Professional Elective -1 XXEAREXXX (3-0-0)	Professional Elective -3 XXEAREXXX (3-0-0)	Open Elective (3-0-0)		
	Kinematics Of Machinery 19EARC202 (4-0-0)	Control Systems 19EARC207 (4-0-0)	Real time Embedded Systems 18EARC304 (4-0-0)	Professional Elective -2 XXEAREXXX (3-0-0)	Professional Elective -4 XXEAREXXX (3-0-0)	Capstone Project 19EARW402 Industry Internship –Project 17EARW494 (0-0-11)		
	Data Structure Algorithm Design and Analysis 18EARC203 (4-1-0)	Microcontrollers Programming & Interfacing 18EARC208 (4-0-0)	Mechatronics System Design 18EARC304 (4-0-0)	Hydraulics And Pneumatics Lab 16EARP302 (0-0-1)	Professional Elective -5 XXEAREXXX (3-0-0)			
	Mechanics Of Materials 18EARC204 (3-0-0)	Object Oriented Programming & DBMS 19EARC209 (4-0-0)	Measurement Systems 18EARC305 (3-0-0)	Mechatronics & Measurements Lab 18EARP304 (0-0-1)	Senior Design Project 19EARW401 (0-0-6)			
	Manufacturing Technology 18EARC205 (3-0-0)	Robot Analysis & Design 18EARC210 (4-0-0)	Machine Learning & ROS Lab 18EARP301 (0-0-1)	Real Time Embedded Systems Lab 16EARP307 (0-0-1)	CIPE 15EHSN401 (0-0-0)			
	Analog & Digital electronics lab 18EARP201 (0-0-1)	Manufacturing & Metrology lab 16EARP205 (0-0-1)	Programming Industrial Automation Systems Lab 18EARP302 (0-0-1)	PA & LR 16EHSC301 (3-0-0)				
	Kinematics Of Machinery lab 18EARP202 (0-0-1)	Microcontrollers Programming & Interfacing Lab 18EARP208 (0-0-1)	Industrial Robotics Lab 18EARP303 (0-0-1)	Minor Project 17EARW302 (0-0-6)				
Machine Drawing Lab 18EARP203 (0-0-1)	Object Oriented Programming & DBMS Lab 19EARP209 (0-0-1)	Mini Project 17EARW301 (0-0-3)						
Credits	26	26	24	22	19	17		

[Signature]
 Program Head



FORM

ISO 9001: 2015- KLE TECH

Department of Automation & Robotics

Document #: FMCD2006

Rev: 1.0

Review-Curriculum Design and Development

Page 1 of 1

Year: 2021-22

Semester: III & IV (2020-24 batch)

Date of Review: 05-06-2021

Inputs for review: PEO- Mapping of CLO with PO – Academic Guidelines-Previous review outcomes

Sr.No	Features reviewed	Status of Review		
		Accepted	Accepted with minor changes	Not accepted
01	Overall schemes of the program			
a	Credits	✓		
b	Flow	✓		
c	Contact hours	✓		
02	Semester wise curriculum structure			
a	Credits	✓		
b	Flow	✓		
c	Contact hours	✓		
d	Evaluation scheme	✓		
03	Course contents			
a	Subject contents	✓		
b	Unitization	✓		
c	Reference books	✓		
d	Evaluation method	✓		

Changes Suggested (Serial number wise)

Reviewed syllabus of all courses of III & IV semesters and approved with no changes suggested by BOS members

Reviewed by (Use initials)	DR. Dhanesh Manik	Mr. Abhijit Lele	Mr. Jitendra Kataria	Supreet Kamatagi	A.C. Giriyapur	Dr. Jyoti Bali	Dr. Vinod Meti	Nagaraj MB	Dr. Sachin Karadgi
Signature	Virtually present	Virtually present	Virtually present	Virtually present	Virtually present	Virtually present	Virtually present	Virtually present	Virtually present










FORM
ISO 9001: 2015- KLE TECH
 Department of Automation & Robotics

Document
#: FMCD2006

Rev: 1.0

Review-Curriculum Design and Development

Page 1 of 1

Year: 2021-22

Semester: V & VI (2019-23 batch)

Date of Review: 05-06-2021

Inputs for review: PEO- Mapping of CLO with PO – Academic Guidelines-Previous review outcomes

Sr.No	Features reviewed	Status of Review		
		Accepted	Accepted with minor changes	Not accepted
01	Overall schemes of the program			
a	Credits	✓		
b	Flow	✓		
c	Contact hours	✓		
02	Semester wise curriculum structure			
a	Credits	✓		
b	Flow	✓		
c	Contact hours	✓		
d	Evaluation scheme			
03	Course contents			
a	Subject contents	✓		
b	Unitization	✓		
c	Reference books	✓		
d	Evaluation method	✓		

Changes Suggested (Serial number wise)

	Reviewed syllabus of all courses of V & VI semester and approved with no changes. Suggested by BOS members.

Reviewed by (Use initials)	DR. Dhanesh Manik	Mr. Abhijit Lele	Mr. Jitendra Kataria	Supreet Kamatagi	A.C.Giriyapur	Dr. Jyoti Bali	Dr Vinod Meti	Nagaraj MB	Dr Sachin Karadgi
Signature	Virtually present	Virtually present	Virtually present	Virtually present	Virtually present	Virtually present	Virtually present	Virtually present	Virtually present

(Handwritten signatures and initials corresponding to the table above)



FORM
ISO 9001: 2015- KLE TECH
 Department of Automation & Robotics

Document
#: FMCD2006

Rev: 1.0

Review-Curriculum Design and Development

Page 1 of 1

Year: 2021-22

Semester: VII & VIII (2018-22 batch)

Date of Review: 05-06-2021

Inputs for review: PEO- Mapping of CLO with PO – Academic Guidelines-Previous review outcomes

Sr.No	Features reviewed	Status of Review		
		Accepted	Accepted with minor changes	Not accepted
01	Overall schemes of the program			
a	Credits	✓		
b	Flow	✓		
c	Contact hours	✓		
02	Semester wise curriculum structure			
a	Credits	✓		
b	Flow	✓		
c	Contact hours	✓		
d	Evaluation scheme	✓		
03	Course contents			
a	Subject contents	✓		
b	Unitization	✓		
c	Reference books	✓		
d	Evaluation method	✓		

Changes Suggested (Serial number wise)

Reviewed syllabus of all courses of VII & VIII semester
 BOS members approved with no changes suggested.

Reviewed by (Use initials)	DR. Dhanesh Manik	Mr. Abhijit Lele	Mr. Jitendra Kataria	Supreet Kamatagi	A.C.Giriapur	Dr. Jyoti Bali	Dr Vinod Meti	Nagaraj MB	Dr Sachin Karadgi
Signature	Virtually present	Virtually present	Virtually present	Virtually present	Virtually present	Virtually present	Virtually present	Virtually present	Virtually present

(Handwritten signatures of the reviewers)



5th June 2021

Agenda

Sl.No	Points to discuss	Documents
1.	Introduction & Review of Actions initiated from previous BOS meeting	Curriculum structure & Syllabus
2.	Review of modifications recommended by the Academic Council after BOS 2020.	
3.	Review and approval of Syllabi for VII & VIII Semester of the batch 2018-22, KLE Tech.	
4.	Review and approval of Syllabi for V & VI Semester of the batch 2019-23, KLE Tech.	
5.	Review and approval of Syllabi for III & IV Semester of the batch 2020-24, KLE Tech.	
6.	Any other points	

Minutes Prepared by

Dr Jyoti Bali

Prof A. C. Giriyapur

Chairperson, HOD, A&R

MINUTES OF THE MEETING, 5TH JUNE 2021

Sl.No	Points raised	Changes made	Raised By
1.0	<p>HOD welcomed the members of the sixth meeting of the Board of Studies-2021 (BOS-2021) of KLE Technological University.</p> <p>Reviewed the minutes of BOS 2020 and briefed about the changes proposed and practised.</p> <p>HOD introduced the way online teaching was carried out from the last academic year. HOD briefed about the arrangements for recording videos for asynchronous sessions and the online sessions, i.e. synchronous sessions.</p> <p>HOD discussed final year project/internship/industry internship activities.</p>	Review done and action proposed	<p>Dr. Dhanesh Manik, IIT Bombay.</p> <p>Dr. Abhijit Lele, Robert Bosch India.</p>
2.0	Review of recommendations by the Academic Council or the Principal after BOS 2021.		Mr. Jitendra Kataria, Beckhoff, Automation India Ltd.Pune
3.0 Curriculum & Syllabus for batch 2018-22	<p>Review of Syllabi for VII & VIII Semester of the batch 2018-22, KLETU</p> <p>No changes proposed in the syllabus, BOS members approved the curriculum structure and the syllabus in the present form.</p>	Review done and Approved	Mr. Supreet Kamatagi, Griffyn Robotech Pvt. Ltd.
3.0 Curriculum & Syllabus for batch 2019-23	<p>Review of Syllabi for V & VI Semester of the batch 2019-23, KLETU.</p> <p>V Sem : No changes were proposed in the syllabus. BOS members approved the curriculum structure and the syllabus in the present form.</p> <p>VI Sem : New Elective introduced titled Robot Dynamics & Control, 17EARE302 for which the course objectives, syllabus content, In semester and end semester assessment was carried out. The elective course was approved.</p>	Review done and Approved.	
4.0 Curriculum & Syllabus for batch 2020-24	<p>Review and approval of Syllabi for III & IV Semester of the batch 2020-24, KLETU.</p> <p>No changes were proposed in the syllabus. BOS members approved the curriculum structure and the syllabus in the present form.</p>	Review done and Approved.	<p>Dr. Dhanesh Manik, IIT Bombay.</p> <p>Dr. Abhijit Lele, Robert Bosch India.</p>
5.0 Experience sharing by Faculty	<ul style="list-style-type: none"> Faculty members shared their experience in recording the asynchronous videos for the allotted subjects in studios and the online interaction with students during synchronous sessions. HOD played some of the recorded videos before the BOS members for their comments. BOS members appreciated the online training of students for the practical exercises on simulation in the laboratories, namely, the use of NPTEL resources in the PIAS lab, Control Systems tutorial and other Programming labs. BOS members welcomed the steps initiated and activities implemented to foster remote learning by students during the Covid pandemic. Mr Jitendra Kataria, MD Beckhoff Automation India, advised 	Review done and Appreciated.	<p>Mr. Jitendra Kataria, Beckhoff, Automation India Ltd.Pune</p> <p>Mr. Supreet Kamatagi, Griffyn Robotech Pvt. Ltd.</p>

	<p>practising the TwinCAT software-based automation exercises in PIAS Lab</p> <ul style="list-style-type: none"> Data Structures Algorithm Design and Analysis: The pedagogy practices and the hand on exercises explained by Mrs Ashwini G K were reviewed and appreciated by BOS members. Measurement Systems Theory and Lab: Practices followed in the theory and lab sessions explained by Dr Vinod M were reviewed and appreciated by BOS members. 		
6.0 Achievements by students	<p>Achievements by Final year students of 2018-22 Batch, A&R as a part of their Project work</p> <p>Humanoid Robot for Banking Sector "MAYA", the Humanoid Robot, is a sponsored project specifically developed to address all "Grahak Mitra" (customer care) needs in a banking system such as guidance for account opening, transactions and also guiding the customers towards the respective counters. This Robot can provide solutions for better customer service, besides marketing, process automation and many others. It houses the additional features, namely, Chatbot, face recognition, automatic docking after discharge and AI-based intelligent decision making in the form of multi-lingual conversations like a human. The cost incurred for the project is five lakhs. Maya robot weighs 15kg with a battery backup of 8-10 hours.</p> <p>Smart India Hackathon (SIH)2020 A team of 6 members from Automation and Robotics and Mechanical engineering students were part of the project, which emerged as Joint Winners of the Challenge SIH 2020. The team has selected the problem statement as Fire Safe Infrastructure for Construction Industry given by the Department of Scientific and Industrial Research. The solution proposed by the team was a robot that was designed to operate remotely. The primary mechanism is a spring-based launcher mechanism that launches fire extinguisher balls. These balls are excellent at clearing out rooms in short amounts of time and can significantly assist rescue operations where speed and efficiency are of paramount importance. The secondary mechanism is a traditional spray based fire extinguisher, which is actuated by a cam mechanism.</p>	Appreciated	<p>Dr. Dhanesh Manik, IIT Bombay.</p> <p>Dr. Abhijit Lele, Robert Bosch India.</p> <p>Mr. Jitendra Kataria, Beckhoff, Automation India Ltd.Pune</p> <p>Mr. Supreet Kamatagi, Griffyn Robotech Pvt. Ltd.</p>
Research @A&R dept	<p>The research group presentation was done by ERG members, namely, Dr Sachin Karadgi, Dr Vinod Meti and Dr Jyoti Bali, briefing about the research activities taken up at the department for grooming research culture in the department. The research focus areas and the themes taken up by faculty teams under the Research domain: Industry 4.0 was presented. The research plan and the path set by different faculty teams were appreciated.</p> <p>Dr Abhijit Lele appreciated the initiatives taken up by faculty members with regards to research activities. He explained the need and the scope of working with Traceability, Accountability factors in digital twin-based applications, namely, Tracking parcels in the Warehouse, Use of Drones for warehouse management, Constant</p>	Review done and Appreciated.	<p>Dr. Dhanesh Manik, IIT Bombay.</p> <p>Dr. Abhijit Lele, Robert Bosch India.</p> <p>Mr. Jitendra Kataria, Beckhoff, Automation India Ltd.Pune</p> <p>Mr. Supreet Kamatagi,</p>

	Temperature tracking in the Supply chain to avoid the spoilage and wastage of vaccines. The external BOS members appreciated the plan of research methodology models introduced for young faculty members. They advised faculty members to apply for research funding from various Govt. schemes.		Griffyn Robotech Pvt. Ltd.
5.0 Final Comments	Approved the initiatives and activities taken up at the department to build the proficiency of faculty members at the academic and research level. VI, BOS Meeting ended with Vote of Thanks proposed by HOD, Dept. A&R, KLETU		

The Curriculum Contents for III and IV Semester of batch 2020-24, IV & V Semester of the batch 2019-23 and VII & VIII Semester of the batch 2018-22 are approved in VI BOS held as Virtual Google Meet 5th June 2021.


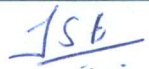

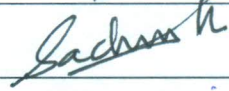

Approved by:

Sl. No	Members, Board of Studies	Signature
1	Prof. A. C. Giriapur, Chairperson, HOD, A & R Dept. KLETU	Present
2	Dr. Dhanesh Manik, IIT Bombay.	Present
3	Dr. Abhijit Lele, Robert Bosch India.	Present
4	Mr. Jitendra Kataria, Beckhoff Automation India . Ltd. Pune	Present
5	Mr. Supreet Kamatagi, Griffyn Robotech Pvt. Ltd.	Present
6	Dr Jyoti Bali, A & R Dept. KLETU	Present <i>Jyoti Bali</i>
7	Dr Vinod Kumar V Meti, A & R Dept. KLETU	Present <i>V. Meti</i>
8	Dr Sachin Karadgi, A & R Dept. KLETU	Present <i>Sachin Karadgi</i>
9	Mr Nagaraj M B, A & R Dept. KLETU	Present <i>NK</i>

Resolutions made during the 6th Board of Studies Meeting held on 5th June 2021 as

- It was resolved to approve Syllabi for the III and IV Semester of batch 2020-24, KLETU.
- It was resolved to approve Syllabi for the V & VI Semester of the batch 2019-23, KLETU.
- It was resolved to approve Syllabi for the VII & VIII Semester of the batch 2018-22, KLETU.
- Curriculum Content for III and IV Semester of the batch 2020-24, V & VI Semester of the batch 2019-23, VII & VIII Semester of the batch 2018-22, in 6th BOS held in Virtual Meeting held through Google Meet 5th June 2021 from 10 am to 12 pm.
- Approved contents of all the courses and laboratories discussed in the BOS meeting are attached to this document.

Approved by:

Sl No	Members, BOS	Signature
1	Prof. A. C. Giriapur, Chairperson, HOD, A & R Dept.	
2	Dr. Dhanesh Manik, IIT Bombay.	Present
3	Dr. Abhijit Lele, Robert Bosch India.	Present
4	Mr. Jitendra Kataria, Beckhoff Automation India . Ltd. Pune	Present
5	Mr. Supreet Kamatagi, Griffyn Robotech Pvt. Ltd.	Present
6	Dr Jyoti Bali, A & R Dept.	
7	Dr Vinod Kumar V Meti, A & R Dept.	
8	Dr Sachin Karadgi, A & R Dept. KLETU	
9	Mr Nagaraj M B, A & R Dept. KLETU	



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**B.E. (Automation & Robotics)
Curriculum Structure & Syllabus
2018 – 22 Batch**



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Semester: VII

Course Code	Course Title	Category						Marks	
			L	T	P	Hrs	Credits	ISA	ESA
16EARC401	Industrial Data Networks	PSC	4	0	0	4	4	50	50
17EARE401	Mobile robotics & Perception	PSE	3	0	0	3	3	50	50
17EARE402	Design of automatic machinery	PSE	3	0	0	3	3	50	50
17EARE403	Advanced Microcontroller	PSE	3	0	0	3	3	50	50
19EARW401	Senior Design Project	PSC	0	0	6	12	6	80	20
15EHSA401	CIPE	HSC	0	0	0	3	0	50	50
Total			13	0	6	28	19		

ISA: Internal Semester Assessment, **ESA:** End Semester Assessment, **L:** Lecture **T:** Tutorials,

P: Practical, **PSC:** Program Scheme Core, **HSC:** Humanities Scheme Core, **BS:** Basic Science



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Semester: VIII

Course Code	Course Title	Category						Marks	
			L	T	P	Hrs	Credits	ISA	ESA
17EARE404	Smart Manufacturing	PSE	3	0	0	3	3	50	50
XXXXX	Open Elective	OE	3	0	0	3	3	50	50
ARW402	Capstone Project	PRJ	0	0	11	22	11	80	20
Total			0	0	17	28	17		
OR									
17EARI493	Internship-Training	IE	0	0	6	6	6	50	50
17EARW494	Industry Internship -Project Work	IEPRJ	0	0	11	11	11	50	50
Total			0	0	17	17	17		

ISA: Internal Semester Assessment, **ESA:** End Semester Assessment, **L:** Lecture **T:** Tutorials,

P: Practical, **PSC:** Program Scheme Core, **HSC:** Humanities Scheme Core, **BS:** Basic Science



Course Content

Course Code: 16EARC401	Course Title: Industrial Data Networks	
L-T-P : 4-0-0	Credits: 4	Contact Hrs: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs
Content		Hrs
Unit I		
Chapter No. 1. DATA NETWORK FUNDAMENTALS AND INDUSTRIAL ETHERNET Modern Instrumentation and Control Systems, Open Systems Interconnection (OSI) Model, Concepts of Parallelization, Sequential, Framing, Bit Encoding, Media Access Control, Error Correction, Time Division, Bit Rate, and Baud Rate, EIA-232, EIA-485, Fiber Optics Overview, Circuit Switching and Packet Switching, Network Topologies, Ethernet, Ethernet Topology, 10 Mbps Ethernet, 1 Gigabit Ethernet, Internetwork Connections Devices (Repeaters, Bridges, Hubs, Switches, Routers and Gateways)		8
Chapter No. 2. TCP/IP IP Version 4 (IPv4), IP Version 6 (IPv6), Address Resolution Protocol (ARP), Internet Control Message Protocol (ICMP), IP Routing, Transmission Control Protocol (TCP), User Datagram Protocol (UDP)		7
Chapter No. 3. MODBUS MODBUS: Protocol Structure, Function Codes		5
Unit II		
Chapter No. 4. FIELDBUS, PROFIBUS AND AS-INTERFACE FIELDBUS: Physical Layer, Data Link Layer and Application Layer of FOUNDATION Fieldbus PROFIBUS: PROFIBUS DP (Decentralized Periphery), PROFIBUS DP Communication Protocol, Application Profiles, PROFIBUS PA (Process Automation) AS-Interface: AS-Interface, Physical Layer, Data Link and Application Layer of the AS-Interface		7
Chapter No. 5. ETHERCAT, ETHERNET POWERLINK AND SERCOS III ETHERCAT: Architecture Model, Protocol, Topology, Distributed Clocks, Device Profiles, EtherCAT Master, EtherCAT Slave Ethernet POWERLINK: Slot Communication Network Management, Physical Layer, Data Link Layer, Transport and Application Layer of Ethernet POWERLINK, Ethernet POWERLINK Addressing, Frame Structures SERCOS III: OSI Layers of SERCOS III, Communication Cycle, Protocol Structure, Topology, Communication Network Infrastructure		8
Chapter No. 6. HART, BLUETOOTH AND OPC HART: HART Protocol, Physical Layer, Data Link Layer and Application Layer of HART. BLUETOOTH: Protocol Stack, Topologies, Generic Data Transport Architecture, Basic		5

Rate/Enhanced Data Rate (BR/EDR) Radio Operation, Low Energy (LE) Operation, Operational Procedures and Modes, Profiles OPC: Enterprise Integration, Manufacturing Execution Systems (MES), Process Analysis, Process Modeling, Data Modeling, Data Flow Diagrams (DFDs), Communication Patterns, Data Collection Technologies, OPC (OLE for Process Control)	
Unit III	
Chapter No. 7. CAN, CAN FD AND DEVICENET CAN: Physical Layer, Data Link Layer and Application Layer of CAN, Protocol, Bus Arbitration, Frames, Bit Stuffing, Bit Synchronization, Bit Timing CAN FD: Physical Layer, Data Link Layer and Application Layer of CAN FD, Protocol, Frames DEVICENET: Physical Layer, Data Link Layer, Network and Transport Layers, and Application Layer of DeviceNet	5
Chapter No. 8. FLEXRAY AND MOST FLEXRAY: Topologies, Protocol, Media Access Control (Communication Cycle), Frame Format, Clock Synchronization MOST: OSI Layers for MOST, Data Frame, Timing Master, Timing Slave, MOST Devices	5

Text Books (List of books as mentioned in the approved syllabus)

1. Steve Mackay, Edwin Wright, Deon Reynders, John Park, "Practical Industrial Data Networks: Design, Installation and Troubleshooting," First edition, Newnes publication, Elsevier, 2004.
2. John Park, Steve Mackay, Edwin Wright, "Practical Data Communications for Instrumentation and Control," First edition, Newnes publication, Elsevier, 2003.

□

References

1. Modbus, <http://www.Modbus.org>.
2. FOUNDATION Fieldbus, <http://www.fieldbus.org>.
3. FOUNDATION Fieldbus, <https://www.fieldcommgroup.org/technologies/foundation-fieldbus/foundation-technology-overview>.
4. ProfiBus, <https://www.profibus.com>.
5. AS-Interface, <http://www.as-interface.net>.
6. HART, <https://www.fieldcommgroup.org/technologies/hart/hart-technology>.
7. EtherCAT, <https://www.ethercat.org>.
8. Ethernet POWERLINK, <https://www.ethernet-powerlink.org>.
9. SERCOS, <https://www.sercos.org>.
10. OPC Foundation, <https://opcfoundation.org>.
11. Bluetooth, <https://www.bluetooth.com>.
12. CAN, <https://www.can-cia.org/can-knowledge>.
13. CAN FD, <https://www.can-cia.org/can-knowledge/can/can-fd>.



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14. DeviceNet, <https://www.odva.org>.
15. FlexRay, <http://www.ni.com/white-paper/3352/en>.
16. Media Oriented Systems Transport (MOST),
<https://www.mostcooperation.com/cooperation/introduction>.



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Course Content

Course Code: 17EARE401	Course Title: Mobile Robots and Perception	
L-T-P-: 3-0-0	Credits: 3	Contact Hrs: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Content	Hrs
Unit - 1	
Chapter No. 01. Introduction to Mobile robots Intelligence and embodiment, A roboticist's problem, challenges of mobile autonomous robots, Locomotion, static and dynamic stability, degrees of freedom. Coordinate systems and frames of reference, forward kinematics, inverse kinematics, inverse kinematics using feedback control.	4 hrs
Chapter No. 02. Path Planning Map representations, path planning algorithms, sampling based path planning, path smoothing, planning at different length scales. Uncertainty and error propagation in robotics, probabilistic robotics, basic concepts in probability.	6 hrs
Chapter No. 03. Recursive State Estimation Robot environment interaction, Bayes filter, representation and computation. Gaussian filters, Kalman filter, extended kalman filter, information filter, histogram filter, particle filter.	5 hrs
Unit - 2	
Chapter No. 04. Robot Motion Kinematic configuration, probabilistic kinematics, velocity motion model, odometry motion model.	7 hrs
Chapter No. 05. Robot Perception Maps, Beam models of range finders, likelihood fields for range finders, correlation-based sensor models, feature-based sensor models.	8 hrs
Unit - 3	
Chapter No. 06. Mobile Robot Localization: Markov and Gaussian Mobile robot localization, Markov localization, EKF localization, Estimating correspondences, multi-hypothesis tracking, grid localization, Monte Carlo localization.	5 hrs
Chapter No. 07. Occupancy Grid Mapping Occupancy grid mapping, Simultaneous localization and mapping, RGB-D SLAM.	5 hrs



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Text Book

- Sebastian Thrun, Wolfram Burgard & Dieter Fox, " Probabilistic Robotics", The MIT Press

Reference Book

- Eugene Kagan, Nir Shvalb & Irad Ben-Gal, "Autonomous Mobile Robots and Multi-Robot Systems ", First Edition, John Wiley & Sons Ltd, 2020.
- Nikolaus Correll, Introduction to Autonomous Robots, 1st edition



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Course Content

Course Code: 17EARE402		Course Title: Design of Automatic Machinery	
L-T-P: 3-0-0		Credits: 3	Contact Hrs: 40
ISA Marks: 50		ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40			Exam Duration: 3 Hrs
UNIT – I			
No	Content	Hrs	
1	Chapter 1: Introduction and Steps to Automation What is Automation, An Automation design process, examples of automation, problems and project assignments? Justifying Automation Traditional Project Cost Justification for a Purchase, Traditional Costing Estimating for Building and Selling Automation, Win–Win Purchasing Philosophy, Maximum Profit Cost Estimating for Building and Selling Automation, Justifying Flexible Automation over Hard Automation, Intellectual Property, Patents, Trade Marks, Copyrights, and Trade Secrets.	6	
2	Chapter 2: The Automation Design Process System Specifications, Brainstorming, Machine Classification by Function, Machine Classification by Transfer Method, Machine Configuration Trade-offs Mechanisms Toolbox, TBBL Automation Project and Conclusions, Case Study Number 1: Case Opening, Case Study Number 2: Label Insertion and Printing, Case Study Number 3: Crossed Four-Bar BMC Unloader.	4	
3	Chapter 3: Workstations Workstation Basics, Drive Mechanisms, Case Study Number 1: TBBL Workstation Design, Case Study Number 2: Automated Screwdriver Workstation Design, Machine Design and Safety. Feeders Feeders, Automatic Feeding and Orienting — Vibratory Feeders, Escapement Feeders, Vibratory Bowl Feeder, Centripetal Feeder, Flexible Feeders, Gravity Feed Tracks, Powered Feed Tracks, Escapements, Parts-Placing Mechanisms, Assembly Robots, Case Study Number 1: Dropping	5	



	Cookies, Case Study Number 2: Feeding of TBBL Cases.	
UNIT – II		
4	Chapter 4: Conveyors Flat Belt Conveyors, Tabletop Chain Conveyor, Belt Conveyors, Static (Gravity) Conveyors, Powered Conveyors, Heavy Unit Load Handling Conveyors, Case Study Number 3: Donut Loader Machine.	3
5	Chapter 5: Single Station Manufacturing Cells Single station manned cells, single station automated cells, applications of single station cells, analysis of single station systems. Manual Assembly Lines Fundamentals of manual assembly lines, Analysis of single model assembly lines, Line balancing algorithms, Mixed model assembly lines, Workstation considerations, Other considerations in assembly line design, Alternative assembly systems. Automated Product Lines Fundamentals of automated product lines, applications of automated product lines, Analysis of transfer lines.	6
6	Chapter 6: Automated Assembly Systems Fundamentals of automated assembly systems, Quantitative analysis of assembly systems. Cellular Manufacturing Part families, part classification and coding, product flow analysis, cellular manufacturing, applications of group technology, quantitative analysis in cellular manufacturing. Flexible Manufacturing Systems Introduction to flexible manufacturing system, flexible manufacturing systems components, flexible manufacturing systems applications and benefits, flexible manufacturing system planning and implementation issues, quantitative analysis of flexible manufacturing systems.	6
UNIT - III		
7	Chapter 7: System Specifications Expectations, Other Problems Beyond Specifications, Example 1: Bulk Mail Carrier (BMC)	5



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	Unloader, Specifications, Design Specifications, Comments, Request for Quote, Example 2: BMC Unloader Bid Award Package.	
8	Chapter 8: Packaging Machines Liquid Filling Machines, Cartoning and Boxes, Labeling, Cases, Palletizing, Forming Pouche, Blister Packs and Bags.	5
TEXT BOOKS: 1. Stephen J. Derby., "Design of Automatic Machinery", 2005 2. Patrick M. McGuire, P.E., "Conveyors", CRC Press, 2010. REFERENCE: 3. Geoffrey Boothroyd, "Assembly Automation and Product Design", Taylor & Francis Group, CRC Press, 2005.		



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Course Content

Course Code: 17EARE403	Course Title: Advanced Microcontrollers	
L-T-P : 3-0-0	Credits: 3	Contact Hrs: 3
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3h
Content		Hrs
Unit - 1		
1.0 Microcontroller Architectures for Low-power behaviour and High-performance capabilities: Requirements of Low-power and High-Performance in autonomous systems built using advanced microcontrollers, Power management, Power-down modes, Case-studies and Examples, Performance of autonomous system, Technologies to enhance the performance of the system, namely, Direct Memory Access, Memory Mapped I/O, Watchdog Timer, Interrupt mechanisms .		7
2.0 MSP430 series Microcontroller devices: Unique architectural features, Addressing modes, Instruction set, Power-down modes , MSP430 Interrupts , Digital Input-Output, On-chip peripherals, Timers, Timer Interrupts, Watchdog Timer, Analog to Digital Converters (ADC), Digital to Analog Converters, Hardware Multiplier, Direct Memory Access Controller (DMA).		8
Unit - 2		
3.0 Advanced Microcontroller for Real-Time control: Key Architectural features of Real-Time Controller, TI C2000 family MCUs, Floating Point Unit, Control Law accelerator, Trigonometric Math Unit, (TMU) , Fast Integer Division Unit (FINTDIV), Complex Math, and CRC Unit (VCU), Example case study on TI C2000 family of MCUs		7
4.0 DisPIC Controller , PIC 30F series: Introduction to 16 bit microcontrollers , dsPIC 30F – CPU, Data memory, Program Memory, Instruction set , Programming in Assembly and C Interrupt Structure. Peripherals of dsPIC 30F: I/O Ports, Timers, Input Capture, Output Compare, Motor Control PWM, Quadrature Encoder Interface(QEI), A/D Converter, UART, CAN Unit, Application Development.		8
Unit - 3		
5.0 Power/ Energy profiling: Profiling of ARM Cortex & MSP430 family devices, Low-power operation, Dynamic Voltage and Frequency Scaling , Optimizing for low power in embedded MCU designs, compiler optimization, parallel programming, run-time optimization, performance analysis & tuning, fault tolerance, and power-aware computing techniques.		5
6.0 Case studies: ARM cortexM3/M4 & MSP430 microcontroller based real-time solutions for application like biomedical system design, machine health monitoring, Energy metering applications etc.		5



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Text Books:

1. Peckol, "Embedded system Design", John Wiley & Sons, 2010
2. John Davies "MSP430 Microcontroller Basics" Second Edition (2008)

References:

1. Shibu.K.V, "Introduction to Embedded Systems", Tata Mcgraw Hill, 2009
2. Steve Furber, ARM System- on-Chip Architecture, 2nd, LPE, 2002
3. Rajkamal, 'Embedded system-Architecture, Programming, Design', TMH, 2011.



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Laboratory Plan

FMTH0303-3.1

Semester: VII

Year: 2020-21

Laboratory Title: Senior Design Project	Lab Code: 19EARW401
Total Hours: 30	Duration of Exam: 3 Hrs
Total ESA Marks: 50	Total ISA. Marks: 50
Lab. Plan Author: Sachin Karadgi	Date: 10-Jan-2020
Checked By: Arunkumar C Giriyaapur	Date: 10-Jan-2020

Prerequisites:

Subjects learnt up to VI semester.

Course Outcomes-CO

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

1. Carry out market survey, do need analysis and identify suitable problems.
2. Write a project proposal, which will involve developing a complete solution for the identified problem from the real world.
3. Apply the principles of engineering design to plan and manage the project.
4. Apply suitable design processes and develop the best possible solution.
5. Develop proof of concepts and models for verification.
6. Prepare production drawings, bill of materials and process plans.



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Course Articulation Matrix: Mapping of Course Outcomes (CO) with Program outcomes (PO)

Laboratory (Course) Title: **Project** Laboratory (Course) code: 17EARW401 Semester: VIII Year: 2019-20

Course Outcomes (CO) / Program Outcomes (PO)	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Carry out market survey, do need analysis and identify suitable problems.	H	H												
2. Write a project proposal, which will involve developing a complete solution for the identified problem from the real world.		H	H		M					H				
3. Apply the principles of engineering design to plan and manage the project.			H											
4. Apply suitable design processes and develop the best possible solution.			H		M		M							
5. Develop proof of concepts and models for verification.			H											
6. Prepare production drawings, bill of materials and process plans.			H							H				

Degree of compliance L: Low M: Medium H: High



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Competency addressed in the Course and corresponding Performance Indicators

Competency	Performance Indicators
1.3 Demonstrate competence in engineering fundamentals	1.3.1 Apply elements of mechanical engineering principles and laws to solve problems
1.3 Demonstrate competence in engineering fundamentals	1.3.2 Apply basic electrical and electronics engineering principles and laws to solve problems
1.3 Demonstrate competence in engineering fundamentals	1.3.3 Apply computer programming skills to solve problems by building algorithms ,flow charts and debugging
1.4 Demonstrate the competence in engineering knowledge appropriate to automation and robotics program	1.4.1 Apply discipline specific laws and principles to solve an interdisciplinary engineering problem
2.1 Demonstrate an ability to identify and characterize an engineering problem	2.1.1 Identifies known and unknown information, uncertainties, and biases when presented with a complex ill-structured problem
2.1 Demonstrate an ability to identify and characterize an engineering problem	2.1.3 Identifies all relevant constraints and requirements and formulate an accurate description of the problem
2.2 Demonstrate an ability to formulate a solution plan and methodology for an engineering problem	2.2.2 Partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design.
2.2 Demonstrate an ability to formulate a solution plan and methodology for an engineering problem	2.2.3 Selects appropriate analysis tools and applies those proficiently to implement the model/solution
3.2 Demonstrate an ability to generate a diverse set of alternative design solutions	3.2.1 Apply formal idea generation tools to develop multiple engineering design solutions
3.2 Demonstrate an ability to generate a diverse set of alternative design solutions	3.2.2 Build models, prototypes, etc., to develop diverse set of design solutions
3.2 Demonstrate an ability to generate a diverse set of alternative design solutions	3.2.3 Identify the suitable criteria for evaluation of alternate design solutions
5.1 Demonstrate an ability to identify/ create modern engineering tools, techniques and resources	5.1.1 Identify modern engineering tools, techniques and resources for engineering activities
7.1 Demonstrate an understanding of the impact of engineering and industrial practice on social, environmental and economic contexts	7.1 1 Identify risks/impacts in the life-cycle of an engineering product or activity
10.3 Demonstrate the ability to integrate	10.3.1 Create engineering-standard figures,



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different modes of communication

reports and drawings to complement writing
and presentations

E.g.: 1.2.3: Represents program outcome '1', competency '2' and performance indicator '3'.

Evaluation Scheme

Students Assessment through ISA (50%) + ESA (50%)

Assessment	Weightage in Marks
ISA	50
ESA	50
Total	100



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Course Content

Course Code: 17EARE404	Course Title: Smart Manufacturing	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 Hrs
Content		Hrs
Unit – I		
Chapter No. 1. Introduction to Smart Manufacturing Introduction to Smart Manufacturing, Smart Manufacturing Ecosystem, Product Development Lifecycle, Production Systems Lifecycle, Business Cycle, Manufacturing Pyramid, Integration, Production Planning and Control, Examples, Standards		3
Chapter No. 2. Supply Chain Management (SCM) Introduction to Supply Chain, SCOR model, Virtual/Extended Enterprise, Delivery Channel, Decision Phases in a Supply Chain, Production Approaches, Supply Chain Process, Push & Pull Production Systems, Push-Pull Boundary, Lack of Coordination and Bullwhip Effect, Order-to-Cash Process, Procure-to-Pay Process, Call-off, Replenishment, Sourcing, Uncertainties, Responsiveness vs Cost, Supply Chain Performance Drivers – Facilities, Inventory, Transportation, Information, Sourcing, and Pricing		7
Chapter No. 3. Enterprise Resource Planning (ERP) Business Processes, Process Modeling and Data Modeling, Business Process Reengineering, Event Process Chains (EPC), ERP Functionalities, Financial Accounting, Cost Accounting and Managerial Accounting, Cost Assignment Techniques, Cost Drivers, Purchasing, Receiving, Inventory Management, Warehouse Management, Shipping and Transportation, Billing, Material Requirement Planning (MRP), Manufacturing Resource Planning (MRP II)		5
Unit – II		
Chapter No. 4. Product Development Lifecycle Product Development Lifecycle, Digital Thread, PLM Overview, Background for PLM, Scope, PLM Grid, PLM Paradigm - Concepts, Business Process in the PLM Environment, Product Data in the PLM Environment, Information Systems in the PLM Environment, Organization Change Management in the PLM Environment, CAD, CAE, CAM, CAPP, Simulations, NC Programming, CMM Programming, Introduction to Digital Twin, Standards		7
Chapter No. 5. Production System Lifecycle Production System Lifecycle, Revisit Production Planning and Control, Manufacturing Pyramid, Manufacturing Execution Systems (MES), MES Functionalities, MES Models, Functional Control Model, MES in Discrete Industry, MES in Process Industry, Data Collection, Traceability, Performance Measurement and Management, Real-Time Enterprise, Revisit Digital Twin, Standards		8
Unit – III		



Chapter No. 6. Cloud Computing Introduction to Cloud Computing, Virtualization Concepts, Main Players, Types of Cloud – Public, Private and Hybrid, Cloud Services – CaaS, SaaS, PaaS, and IaaS, Service Level Agreement, Cloud Security, Leveraging Cloud Services for Smart Manufacturing, Cloud Computing at Enterprise Systems Level, Hybrid Cloud Options	5
Chapter No. 7. Key Focus Areas Knowledge Management, Case-Based Reasoning (CBR), Big Data Analytics, Smart Maintenance, Smart Product, Smart Supply Chain, Intelligent Machines, Smart Services, Blockchain	5

Text Books (List of books as mentioned in the approved syllabus)

1. Sunil Chopra, and Peter Meindl, "Supply Chain Management – Strategy, Planning, and Operation," Pearson Education, Sixth Edition, 2016.
2. Ellen Monk, and Bret Wagner, "Concepts in Enterprise Resource Planning," Fourth Edition, Course Technology CENGAGE Learning, 2009.
3. Stark John, "Product Lifecycle Management: 21st Century Paradigm for Product Realization," Springer, Third Edition, 2015.
4. Sachin Karadgi, "A Reference Architecture for Real-Time Performance Measurement," Springer, 2014.
5. Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter, "Cloud Computing – A Practical Approach," McGraw Hill Education, 2010.

References

1. Y. Lu, K.C. Morris, S. Frechette, "Current Standards Landscape for Smart Manufacturing Systems," National Institute of Standards and Technology (NIST), (2016).
2. MESA International, "Three Functional Dimensions Converge on Smart Manufacturing," Whitepaper #59, 2018.
3. MESA International, "Smart Manufacturing and Cloud Computing," Whitepaper #60, 2018.



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Laboratory Plan

FMTH0303-3.3

Semester: VIII

Year: 2021-22

Laboratory Title: Capstone Project	Lab Code: 19EARW402
Total Hours: 30	Duration of Exam: 3 Hrs
Total ESA Marks: 20	Total ISA. Marks: 80
Lab. Plan Author: Sachin Karadgi	Date:
Checked By: Arunkumar C Giriyapur	Date:

Prerequisites:

Subjects learnt up to VII semester.

Course Outcomes-CO

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

7. Carry out market survey, do need analysis and identify suitable problems.
8. Write a project proposal, which will involve developing a complete solution for the identified problem from the real world.
9. Apply the principles of engineering design to plan and manage the project.
10. Apply suitable design processes and develop the best possible solution.
11. Develop proof of concepts and models for verification.
12. Prepare production drawings, bill of materials and process plans.



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Course Articulation Matrix: Mapping of Course Outcomes (CO) with Program outcomes (PO)

Laboratory (Course) Title: **Project** Laboratory (Course) code: 18EARW402 Semester: VIII Year: 2020-21

Course Outcomes (CO) / Program Outcomes (PO)	1	2	3	4	5	6	7	8	9	10	11	12	13	14
7. Carry out market survey, do need analysis and identify suitable problems.	H	H												
8. Write a project proposal, which will involve developing a complete solution for the identified problem from the real world.		H	H		M					H				
9. Apply the principles of engineering design to plan and manage the project.			H											
10. Apply suitable design processes and develop the best possible solution.			H		M		M							
11. Develop proof of concepts and models for verification.			H											
12. Prepare production drawings, bill of materials and process plans.			H							H				

Degree of compliance L: Low M: Medium H: High



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Competency addressed in the Course and corresponding Performance Indicators

Competency	Performance Indicators
1.3 Demonstrate competence in engineering fundamentals	1.3.1 Apply elements of mechanical engineering principles and laws to solve problems
1.3 Demonstrate competence in engineering fundamentals	1.3.2 Apply basic electrical and electronics engineering principles and laws to solve problems
1.3 Demonstrate competence in engineering fundamentals	1.3.3 Apply computer programming skills to solve problems by building algorithms ,flow charts and debugging
1.4 Demonstrate the competence in engineering knowledge appropriate to automation and robotics program	1.4.1 Apply discipline specific laws and principles to solve an interdisciplinary engineering problem
2.1 Demonstrate an ability to identify and characterize an engineering problem	2.1.1 Identifies known and unknown information, uncertainties, and biases when presented with a complex ill-structured problem
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different modes of communication	reports and drawings to complement writing and presentations
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E.g.: 1.2.3: Represents program outcome '1', competency '2' and performance indicator '3'.

Evaluation Scheme

Students Assessment through ISA (50%) + ESA (50%)

Assessment	Weightage in Marks
ISA	80
ESA	20
Total	100



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**B.E. (Automation & Robotics)
Curriculum Structure & Syllabus
2019 – 23 Batch**



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Semester: V

Course Code	Course Title	Category						Marks	
			L	T	P	Hrs	Credits	ISA	ESA
18EARC301	Machine Learning & ROS	PSC	3	0	0	3	3	50	50
18EARC302	Programming Industrial Automation Systems	PSC	4	0	0	4	4	50	50
18EARC303	Real time Embedded Systems	PSC	4	0	0	4	4	50	50
18EARC304	Mechatronics System Design	PSC	4	0	0	4	4	50	50
18EARC305	Measurement Systems	PSC	3	0	0	3	3	50	50
18EARP301	Machine Learning & ROS Lab	PSC	0	0	1	2	1	80	20
18EARP302	Programming Industrial Automation Systems Lab	PSC	0	0	1	2	1	80	20
18EARP303	Industrial Robotics Lab	PSC	0	0	1	2	1	80	20
18EARW301	Mini project – (Engineering Design Project)	PRJ	0	0	3	6	3	80	20
Total			18	0	6	30	24		

ISA: Internal Semester Assessment, **ESA:** End Semester Assessment, **L:** Lecture **T:** Tutorials,

P: Practical, **PSC:** Program Scheme Core, **HSC:** Humanities Scheme Core, **BS:** Basic Science



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Semester: VI

Course Code	Course Title	Category						Marks	
			L	T	P	Hrs	Credits	ISA	ESA
18EARC308	Hydraulics & Pneumatics	PSC	4	0	0	4	4	50	50
17EARE301	Department Elective 1 (AI for Autonomous Robots)	PSE	3	0	0	3	3	50	50
15EARE302	Department Elective 2(Computer Vision & Digital image processing)	PSE						50	50
16EARE301	Department Elective 3 (Power electronics, motors & Drives)	PSE	3	0	0	3	3	50	50
17EARE304	Department Elective 4 (Digital System Design & FPGA programming)	PSE						50	50
16EARP302	Hydraulics And Pneumatics Lab	PSC	0	0	1	2	1	80	20
18EARP304	Mechatronics & Measurements Lab	PSC	0	0	1	2	1	80	20
16EARP307	Real time Embedded Systems Lab	PSC	0	0	1	2	1	80	20
17EARW302	Minor project	PRJ	0	0	6	12	6	80	20
16EHSC301	PALR	HSC	3	0	0	3	3		
Total			13	0	9	31	22		

ISA: Internal Semester Assessment, **ESA:** End Semester Assessment, **L:** Lecture **T:** Tutorials,

P: Practical, **PSC:** Program Scheme Core, **HSC:** Humanities Scheme Core, **BS:** Basic Science



Course Content

Course Code: 18EARC301	Course Title: Machine learning and ROS	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration : 3 hours
Content		Hours
UNIT - 1		
<p>Chapter 1: Introduction to Robot operating system ROS concepts, creating ROS packages writing a minimal ROS publisher, compiling ROS nodes, running ROS nodes, examining running minimal publisher node, scheduling node timing, writing a minimal ROS subscriber compiling and running minimal subscriber, minimal subscriber and publisher node summary writing ROS nodes more ROS tools: catkin simple, ROS launch, simplifying cmakeLists.txt with catkin simple automating starting multiple nodes viewing output in a ROS console recording and playing back data with ROSbag.</p>		5 hrs
<p>Chapter 2: Messages, Classes and Servers in ROS Defining custom messages, ROS services- service messages, ROS service nodes, manual interaction with ROS services, example ROS service client, running, example service and client, using C++ classes in ROS creating library modules in ROS, introduction to action servers and action clients- creating an action server package, defining custom action-server messages, designing an action client running the example code, introduction to parameter server.</p>		5 hrs
<p>Chapter 3: Introduction to machine learning Introduction Machine Learning ,Well posed learning problem, Types of learning, supervised learning ,unsupervised learning and reinforcement learning, Learning Associations, Designing of learning system, perspectives & issues in machine learning, Concept learning task, concept learning search, Find-S: Finding a maximally specific hypotheses, version spaces & candidate elimination algorithm, Remarks - version spaces & candidate elimination algorithm, inductive bias.</p>		5 hrs
UNIT - 2		
<p>Chapter 4: Computational learning theory and decision tree learning Motivation, Estimating hypotheses accuracy, Basics of sampling theory, general approach for deriving confidence intervals, comparing learning algorithm. Probably learning an approximately correct hypothesis, sample complexity for finite hypothesis spaces, sample complexity for infinite hypothesis spaces, instance based learning-K nearest neighbor learning, locally weighted regression, Representation, decision tree algorithm, hypotheses space search in decision tree algorithm inductive bias in decision tree algorithm, issues in DTL, Bayesian decision theory classification.</p>		8 hrs



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Chapter 5: Kernel methods and Graphical models Embedding's into feature spaces, the kernel trick, Multiple kernel learning, Kernel dimensionality reduction Canonical Cases for Conditional Independence, Example Graphical Models, Naive Bayes' Classifier, Hidden Markov Model, Linear Regression, d-Separation Belief Propagation, Linkage-Based clustering algorithms-means and other cost minimization clustering.	7 hrs
UNIT - 3	
Chapter 6: Reinforcement Learning The learning task, Q-learning, Nondeterministic rewards & actions, temporal difference learning, generalizing from examples, relationship to dynamic programming.	5 hrs
Chapter 7: Artificial neural network Biological motivation, neural network representations, and appropriate problems for neural network learning, perceptron's, multilayer networks and the back propagation, algorithm, an illustrative example: face recognition	5 hrs

Text Book (List of books as mentioned in the approved syllabus)

1. Wyatt S. Newman "A Systematic Approach to Learning Robot Programming with ROS" CRC Press Taylor & Francis Group, 2018
2. Tom Mitchell "Machine Learning" McGraw-Hill Science/Engineering/Math (March 1, 1997).

References

1. Shai shalev-schwartz and Shai Ben David "Understanding Machine Learning" First Edition, Cambridge Press, USA, 2014.
2. Anis Koubaa "Robot Operating System" The Complete Reference (Volume 1), Springer publications, 2016



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Course Content

Course Code: 18EARC302	Course Title: Programming Industrial Automation Systems	
L-T-P-: 4-0-0	Credits: 4	Contact Hrs: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs
Content		Hrs
Unit - 1		
Chapter No. 01. Programmable logic controllers(PLC) & its building blocks Internal architecture of Programmable Logic Controllers systems, Input/ Output devices, Memory Organization, I/O processing, Signal conditioning, Remote connections, Networks, Processor Scan cycle, Error Checking and Diagnostics.		6 hrs
Chapter No. 02. The IEC 61131 , IEC61499 standards & Ladder , FB, IL, SFC and ST programming IEC 61131-3: Building Blocks , Goals , benefits , , Programming Languages of IEC 61131-3, Ladder diagrams, Analogy with Boolean Algebra and Binary Logic , Function blocks, Instruction lists, Sequential function charts, State chart modelling, Structured text programming with example programs for each, IEC 61499 models: models ,concepts and industrial examples like Temperature control system, Conveyor test station		9 hrs
Chapter No. 03. Advanced PLC functions PLC Sequencer, Shift registers, Program / Flow Control Instructions, Arithmetic Instructions, Data handling Instructions like FIFO, FAL, ONS, Data Transfer Instructions PLC MOVE, PLC Matrix functions, Network Communication Instructions, Analog PLC operation, PID control of continuous processes.		5 hrs
Unit - 2		
Chapter No. 04. Designing systems, PLC Start-up & Maintenance PLC Core application development, Development Cycle, Safe systems, Commissioning, Fault finding, PLC System Layout , Power Requirements and Safety Circuitry , Noise, Heat, and Voltage Considerations,, I/O Installation, System wiring strategies, and Precautions , Safety Standards like NEMA & NEC, Electrical wiring diagrams PLC Start-Up and Checking Procedures , PLC System Maintenance & Troubleshooting		10 hrs
Chapter No. 05. PC based Automation, SCADA Technologies and advantages of PC based Automation, Programmable Automation Controller systems (PACs) for Industrial control , Comparison of PLC with PAC Supervisory Digital Control and Data Acquisition (SCADA) system & Distributed Control Systems(DCS): SCADA Hardware and software ,Open SCADA protocols like DNP3 and IEC60870,		10 hrs
Unit - 3		
Chapter No. 06. DCS & Field Bus		5 hrs



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Overview of DCS, Network Standards: Device net, CAN bus, Control Net, Profibus, Sercos, EtherCAT, Ethernet Powerlink, Comparison of each of them with other network standard.	
Chapter No. 07. System Selection Guidelines & Commissioning PLC Selection process ,estimation of program memory and time requirements, PLC Sizes and Scope of applications, Special I/O modules, Electrical relay diagram symbols, Fail Safe Design, IEC 61508/61511 safety standards, Process modeling, Programming for large systems ,Control system documentation & Commissioning	5 hrs

Text Book (List of books as mentioned in the approved syllabus)

- John W. Webb & Ronald A Reis , "Programmable Logic Controllers: Principles and Applications ", Fifth Edition, PHI, 2012
- W. Bolton , Programmable Logic Controllers , Fourth Edition, ELSEVIER, 2009

References

- Frank D. Petruzella , Programmable Logic Controllers , McGraw- Hi, 1989
- Siemens , PLC Handbook,



Course Content

Course Code: 18EARC303	Course Title: Real Time Embedded Systems	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs
Content		Hrs
Unit - 1		
1.0 Introduction to System Structures and Real-time Embedded System System Structures types, Real-time systems & basics, Classification, Example case studies, namely, Process control system, Avionics system, Multimedia systems, Intensive Care Computing, Modern car, Digital Flight control system, Embedded system purpose, Quality attributes, Challenges and characteristics of Embedded Computing System Design, Embedded System Design Process, Core and Supporting components of the embedded system, Embedded firmware, discussion on real-time case studies and block diagram representation of systems, Embedded design cycle-case study- Engine Control Unit , GPS Moving Map, Automatic Chocolate Vending Machine (ACVM) using Finite State machine(FSM), Unified Modeling Language(UML), state charts etc.		6
2.0 Target Architectures : ARM Cortex M3 processors & its Programming Introduction to embedded computing with examples and arm processors, The architecture of ARM Cortex M3, Nested Vector Interrupt Controller. Interrupt behavior of ARM Cortex M3. Exceptions Programming. Advanced Programming Features. Memory Protection. Debug Architecture. Digital Signal Processor (DSP), Field Programmable Generic Array (FPGA). Examples to demonstrate each of its architectural and programmable features. A case study on the Antilock Brake System(ABS) and stability control system		7
3.0 Real-Time Kernels and Operating Systems Introduction to Real-Time Kernels, Tasks, process and threads, Introduction to RTOS, key characteristics of RTOS, its kernel, components in RTOS kernel, objects, scheduler, services, context switch, Task scheduling, Task communication and synchronization, Multiprocessing and multitasking, Multi-Threading, Hyper-threading, State diagrams, timing diagrams, examples for each, Scheduling types: Preemptive priority-based scheduling, Round-robin and preemptive scheduling. First come first served scheduling, shortest job first scheduling, Device drivers and selection of an RTOS. Examples for each of the scheduling technique, objects, context switching, synchronization, and device drivers, Case study on Mars Pathfinder mission		7
Unit - 2		
4.0 Inter-task Communication in RTOS Tasks, Semaphores and Message Queues: A task, its structure, A typical finite state machine, Steps showing the how FSM works. A semaphore, its structure, binary semaphore, mutual exclusion (MUTEX) semaphore, Synchronization between two tasks and multiple tasks, Single shared-resource-access synchronization, Recursive shared-resource-access synchronization. A message queue, its structure, Message copying and memory use for sending and receiving messages, Sending messages in FIFO or LIFO		7



order, broadcasting messages., Demonstration of each of the objects of Inter-process communication, namely, semaphore, Message Queue, MUTEX, Mailbox, etc. Case-study on Magnetic Resonance Imaging (MRI)	
5.0 Tasks and Task Management RTOS - task creation and Management, task scheduling, kernel services, inter-task-communication, Micro C/OS-II- task creation and Management, task scheduling, kernel services, inter-task-communication, Demo on Task creation and management functions. Case studies on Industrial Robot, Weapons Defence System, Adaptive Cruise control	7
6.0 Handling Deadlocks Sharing Resources, Deadlock Model- Necessary Conditions, A Graph-Theoretic Tool— The Resource Allocation Graph, Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Demonstration on Handling of deadlocks, identification through a case study, The Dynamic Dining Philosopher problem.	6
Unit - 3	
7.0 Performance Analysis and Optimization Performance or Efficiency Measures, Complexity Analysis—A High-Level Measure, The Methodology, Analyzing Code, algorithms, Response Time, Time Loading, Memory Loading, Evaluating Performance, Performance Optimization, optimizing for Power Consumption. Demonstration of concepts of Performance Analysis and Optimization through a case-study.	5
8.0 Wired and Wireless Protocols used in Real-Time Embedded System: Bus communication protocol (USB, I2C, SPI), Wireless and mobile system protocol (Bluetooth, 802.11 and its variants, ZigBee), Examples of block diagrams to explain the working of each protocol for a specified application.	5

Text Books:

James K. Peckol, "Embedded Systems A Contemporary Design Tool," Wiley student edition
Joseph Yiu "The Definitive Guide to the ARM Cortex-M3"
Silberschatz, Galvin, and Gagne, "Operating system concepts," 8th edition, WILEY Publication.

References:

1. Shibu K V, "Introduction to Embedded Systems Tata McGraw Hill, New Delhi, 6th reprint 2012.
2. Raj Kamal, "Embedded Systems," McGraw-Hill Education
3. Steve Furber, "ARM System-on-Chip Architecture" LPE, Second Edition.



Course Content

Course Code: 18EARC304	Course Title: Mechatronics System Design	
L-T-P : 4-0-0	Credits: 4	Contact Hrs: 50 hours
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50 hours		Exam Duration: 3 Hrs
Content		Hrs
Unit - I		
1. Introduction to Mechatronics Systems and elements Introduction to Mechatronic Systems and Design, Mechatronic systems in Precision mechanics, Micromechanics and Process Engineering , Confinement of Mechatronic Systems , Functions, Distribution of Mechanical and Electronic Functions, Integration Forms of Processes and Electronics , Ways of Information Processing , Multi-level Control Systems , Special Signal Preprocessing, Design Procedures for Mechatronics Systems, V model		8
2. Modeling of Processes Theoretical and Experimental Modeling , Classification of Process Elements , Process Elements with Lumped and Distributed Parameters , Mechanical System model , Mechanical Elements : Bars ,Springs, Dampers , Mechanical Systems with Friction , Backlash , Electrical System model, Analogies between Mechanical and Electrical Systems, Dynamics of Mechanical Systems, Newton's Laws of Kinetics , Translational and Rotational Motion, Principles of Mechanics, d'Alembert's Principle , Lagrange's Equations, Problems.		12
Unit - II		
3. Electrical Drives Types of Electrical Drives, Electromagnets , Direct Current Motors , Dynamic Behavior , Static Behavior , Special Types of DC Motors , Alternating Current Motors (AC) , Induction Motors, Synchronous Motors , Single-phase Motors , Commutator Motors (Universal Motors) , Squirrel-cage Motors , Power Electronics Circuits , Internally or Externally Commutated Electro-motors , Electrical Motor Sizing and Selection Procedure, Electric Motor Operational Conditions, Motion Profile, Load Torque Calculation, Motor Shaft Torque Calculation, Load Torque-Speed Profile , DC Motor Parameter Estimation, Process Dynamics Particularities, Electrical Binary Actuators.		10
4. Model based Design of Systems & Identification Introduction to model based design ,Basic block diagrams, Model-based Methods of Control, Supervision and Fault Diagnosis, Intelligent Systems, Non-linear Control and Fault Detection , Model-based Compensation of Non-linearities, Modeling and Fault Diagnosis , Examples for the Design of Mechatronic Systems using UML and SysML, Identification Methods , classification of Identification Methods ,Test Signals , Closed-loop Identification , Type of Application, Parameter Estimation for Discrete Time-varying Systems, Non-linear Processes, Problems.		10
Unit - III		
5. Recent trends in Mechatronics System Design process Mechatronics systems contributing to economic growth, Changes in technological processes and products, Tools and methods in mechatronics system design and development, Use of Artificial Neural Networks and Fuzzy-logic Models , Fields of application, Future Mechatronics systems.		5
6. Case studies Dynamic Models of a Electromagnetic actuator, Control Prototyping and Hardware-in-the-loop Simulation, Rapid Control Prototyping for Engine Control, Hardware-in-the-loop Simulation for Industrial Robot , Process control system, etc, UML/ SysML and State chart modeling for each example.		5



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Text Books

1. Rolf Isermann, "Mechatronic Systems: Fundamentals", Springer, 1st edition, 2005.
2. Alexandru Forrai, "Embedded Control System Design: A Model Based Approach", Springer, 1st edition, 2013.
3. Patrick O.J. Kaltjob, "Mechatronic Systems and Process Automation: Model-Driven Approach and Practical Design Guidelines", CRC Press, 1st edition, 2018.
4. Norman S. Nise, "Control Systems Engineering", John Wiley & Sons Inc, Sixth Edition, 2011.

Reference Books

1. Devdas Shetty, Richard A. Kolk, "Mechatronics System Design", Cengage Learning, Second edition, 2010.
2. "Mechatronics Handbook" Edited by Robert Bishop. CRC Press, 2002.
Ioan D. Landau and Gianluca Zito, "Digital Control Systems: Design, Identification and Implementation", Springer, 2006.
3. George Pelz, "Mechatronic Systems: Modeling and Simulation with HDL", Wiley, 2003
4. Wei Wu, "Model-Based Design for Effective Control System Development", IGI Global, 1st edition, 2017.



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Course Content

Course Code: 18EARC305	Course Title: Measurement Systems	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40 hours
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Duration of ESA: 3 Hrs
Content		Hrs
Unit – I		
Chapter No. 1. Introduction to Measurement Systems Need for study of Measurement Systems, Classification of Types of Measurement Applications, Computer-Aided Machines and Processes, Functional Elements of an Instrument , Active and Passive Transducers , Analog And Digital Modes of Operation , Null and Deflection Methods , Input-Output Configuration of Instruments and Measurement Systems, Static Characteristics and Static Calibration, Dynamic Characteristics.		5 hrs
Chapter No. 2. Sensors and Signal conditioning Sensor characterization, Relations between physical quantities, Sensor Classification, Specifications, Error reduction techniques, Loading errors, Signal conditioning processes, The operational amplifier, Filtering, Wheatstone bridge, Pulse modulation.		5 hrs
Chapter No. 3. Motion Measurement Fundamental Standards, Relative Displacement: Translation and Rotational, Relative Velocity: Translation and Rotational, Relative-Acceleration Measurements, Displacement Pickups, Velocity Pickups, Acceleration Pickups, Calibration and Vibration Pickups, Jerk Pickups.		5 hrs
Unit – II		
Chapter No. 4. Force, Torque, and Shaft Power Measurement Standards and Calibration, Basic Methods of Force Measurement, Characteristics of Elastic Force Transducers, Torque measurement on Rotating shaft, Shaft Power Measurement (Dynamometers), Vibrating Wire Force Transducers.		5 hrs
Chapter No. 5. Pressure & Sound Measurement Standards and Calibration, Basic Methods of Pressure Measurement, Deadweight Gages and Manometers, Elastic Transducers, Vibrating-Cylinder and Other Resonant Transducers, Dynamic Testing of Pressure-Measuring Systems, High-Pressure Measurement, Low-Pressure Measurement, Sound Measurement.		5 hrs
Chapter No. 6. Flow and Temperature Measurement Local Flow Velocity, Magnitude and Direction, Gross Volume Flow Rate, Standards and Calibration of Temperature Measurement, Thermal-Expansion methods, Thermoelectric Sensors, Electrical-Resistance Sensors, Junction Semiconductor Sensors, Digital Thermometers, Radiation Methods.		5 hrs
Unit – III		
Chapter No.7. Data Acquisition Systems Data conversion devices, Signal sampling and aliasing, Sampling theorem, Quantization, Encoding, Digital to analog conversion methods, Analog to digital conversion methods, Sample & Hold circuit, Flash ADC, Successive approximation ADC, Dual slope ADC, Sigma Delta ADC, Multiplexers.		5 hrs
Chapter No. 8. Transmission and Recording of Data Cable Transmission of Analog Voltage and Current Signals, Cable Transmission of Digital Data, Fiber-Optic Data		



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Transmission, Analog Voltmeters and Potentiometers, Electrical Instruments, Digital Voltmeters and Multimeters, Signal Generation, Electromechanical XT and XY Recorders, Fiber Optic Sensors.

5
hrs

Text Books:

1. Ernest O. Doebelin and Dhanesh N. Manik, "Measurement Systems", Sixth Edition, McGraw Hill Education Pvt Ltd, 2011.
2. W. Bolton, "Mechatronics – Electronic Control Systems in Mechanical and Electrical Engineering", Fourth Edition, PEARSON, 2010.

References:

1. Sabri Cetinkunt "Mechatronics with Experiments", WILEY, Second Edition, 2015.
2. J. P. Holman, "Experimental Methods for Engineers", Eighth Edition, McGraw Hill Education Pvt Ltd, 2012.



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List of Experiments

Laboratory Title: Industrial Robotics Lab	Lab. Code: 18EARP303
Total Hours: 28	Duration of Exam: 3 hrs.
ISA Marks: 80	ESA. Marks: 20

Experiment wise Plan

List of experiments/jobs planned to meet the requirements of the course.

Category: Exercise		Total Weightage: 70.00		No. of lab sessions: 8.00
Expt./ Job No.	Experiment / Job Details	No. of Lab Session(s) per batch (estimate)	Marks / Experiment	Correlation of Experiment with the theory
1	Matlab Introduction	1.00	10	
	<p>Millions of engineers and scientists worldwide use MATLAB® to analyze and design the systems and products transforming our world. The matrix-based MATLAB language is the world's most natural way to express computational mathematics. Built-in graphics make it easy to visualize and gain insights from data. The desktop environment invites experimentation, exploration, and discovery. These MATLAB tools and capabilities are all rigorously tested and designed to work together.</p> <p>MATLAB helps you take your ideas beyond the desktop. You can run your analyses on larger data sets, and scale up to clusters and clouds. MATLAB code can be integrated with other languages, enabling you to deploy algorithms and applications within web, enterprise, and production systems.</p> <p>Topics:</p> <ol style="list-style-type: none"> 1. Basic commands 2. Vectors and Matrices 3. Importing Data 4. Plotting Data <p>Technically speaking, MATLAB is not a programming language but it is a tool with which you can find engineering solutions based on mathematics. Robotic developers need to learn MATLAB if they want to analyze data, produce advanced graphs or implement control systems.</p> <p>MATLAB, and its open source relatives, such as Octave, is very popular with some robotic engineers for analyzing data and developing control systems.</p> <p>Programming for a robot requires designing the controller that governs robot behavior. Modeling and simulation became vital to understand how the controller interacts with the robot's environment perception, mobility, and interaction.</p> <p>Why MATLAB is the Most Used Programming Language in Robotics?</p> <ul style="list-style-type: none"> • MATLAB is highly useful in designing the entire robotic system. • It is widely used in the robotics industry as it is deeply rooted in the foundation and development of robots. 			UNIT – I



	<ul style="list-style-type: none"> It is a simulation tool whereby you can provide your algorithm or design and it simulates the result. On the other hand, simulation helps engineers to refine the system design and eliminate errors before developing hardware prototypes. 																																
2	Robotics Toolbox	1.00	10																														
	<p>The Toolbox has always provided many functions that are useful for the study and simulation of classical arm-type robotics, for example such things as kinematics, dynamics, and trajectory generation.</p> <p>The toolbox contains functions and classes to represent orientation and pose in 2D and 3D (SO (2), SE (2), SO (3), SE (3)) as matrices, quaternions, twists, triple angles, and matrix exponentials. The Toolbox also provides functions for manipulating and converting between data types such as vectors, homogeneous transformations and unit-quaternions which are necessary to represent 3-dimensional position and orientation.</p>		UNIT - I																														
3	RoboAnalyzer	2.00	20																														
	<p>Explaining the concepts in a course on Robotics typically requires a 3D model of a serial-robot/manipulator, either in the form of a physical robot or a virtual robot in software environment, for a better understanding. With the experience of handling Robotics courses and the feedback received so far, we have come up with a list of Virtual Experiments using RoboAnalyzer.</p> <p>List of Virtual Experiments using RoboAnalyzer</p> <table border="1"> <thead> <tr> <th>Sl No.</th> <th>Practical Assignments using RoboAnalyzer</th> <th>Topics Covered</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Introduction to RoboAnalyzer</td> <td>Usage of RoboAnalyzer</td> </tr> <tr> <td>2</td> <td>Virtual Models of Industrial Robots</td> <td>Industrial Robots</td> </tr> <tr> <td>3</td> <td>Understanding coordinate frames and transformations</td> <td>DH Parameters, Robot Geometry</td> </tr> <tr> <td>4</td> <td>Forward kinematics of robots</td> <td>Robot Kinematic Analysis</td> </tr> <tr> <td>5</td> <td>Inverse kinematics of robots</td> <td>Robot Kinematic Analysis</td> </tr> <tr> <td>6</td> <td>Case Study: Kinematics of MTAB Mini Robot</td> <td>Robot Kinematic Analysis</td> </tr> <tr> <td>7</td> <td>Case Study: Workspace Analysis of a 6 axis robot</td> <td>Workspace Analysis</td> </tr> <tr> <td>8</td> <td>Inverse and Forward dynamics of robots</td> <td>Robot Dynamics</td> </tr> <tr> <td>9</td> <td>Creating robot joint trajectories</td> <td>Trajectory Planning</td> </tr> </tbody> </table>	Sl No.	Practical Assignments using RoboAnalyzer	Topics Covered	1	Introduction to RoboAnalyzer	Usage of RoboAnalyzer	2	Virtual Models of Industrial Robots	Industrial Robots	3	Understanding coordinate frames and transformations	DH Parameters, Robot Geometry	4	Forward kinematics of robots	Robot Kinematic Analysis	5	Inverse kinematics of robots	Robot Kinematic Analysis	6	Case Study: Kinematics of MTAB Mini Robot	Robot Kinematic Analysis	7	Case Study: Workspace Analysis of a 6 axis robot	Workspace Analysis	8	Inverse and Forward dynamics of robots	Robot Dynamics	9	Creating robot joint trajectories	Trajectory Planning		UNIT-I & II
Sl No.	Practical Assignments using RoboAnalyzer	Topics Covered																															
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4	Introduction to ABB Robotstudio	1.00	5.00	
	<p>Offline programming is the best way to maximize return on investment for robot systems. ABB's simulation and offline programming software, RobotStudio, allows robot programming to be done on a PC in the office without shutting down production.</p> <p>RobotStudio provides the tools to increase the profitability of your robot system by letting you perform tasks such as training, programming, and optimization without disturbing production. This provides numerous benefits including:</p> <ol style="list-style-type: none">1. Risk reduction2. Quicker start-up3. Shorter change-over4. Increased productivity <p>RobotStudio is built on the ABB VirtualController, an exact copy of the real software that runs your robots in production. This allows very realistic simulations to be performed, using real robot programs and configuration files identical to those used on the shop floor.</p>			UNIT-I & II
5	Simulation/Offline Programming (Robotstudio)	2.00	15.00	
	<p>Topics to be covered:</p> <ol style="list-style-type: none">1. Create mechanism2. AutoPath3. Set Task Frame4. Collision control5. Reachability6. Create MultiMove System from Layout			UNIT-I & II
6	Online Programming	1.00	10	
	<p>To perform a particular action, robots are programmed either by guiding or by off-line programming. Most of the industrial robots are programmed by guiding a robot from point to point through the phases of an operation, with each point stored in the robotic control system.</p> <p>Robots receive instructions through computer commands and this is referred to as manipulator level off-line programming. Usage of off-line programming involves higher-level languages, in which robotic actions are defined by tasks or objectives.</p> <p>Robotic programmers must have knowledge on different types of programming languages as switching from computers to robots is not the smooth transition that many developers/programmers may think.</p>			UNIT-I & II
Category: Structured Enquiry		Total Weightage: 20.00		No. of lab sessions: 1.00



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Expt./ Job No.	Experiment / Job Details	No. of Lab Session(s) per batch (estimate)	Marks / Experiment	Correlation of Experiment with the theory
7	<p>Project</p> <p>Students should form a team of 4 in numbers and select a problem or need statement in industrial robotics area.</p> <p>The project should consists of following requirements:</p> <p>Minimum 3 to 6 DOF robot arm DH Parameters</p> <p>Students are free to choose the software to complete the project</p>	1	20.00	UNIT-I & II



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Department of Automation & Robotics

Laboratory Title: Programming Industrial Automation Systems Lab	Lab Code: 18EARP302
Total Hours: 28	Duration of ESA Hours: 2
ESA Marks: 20	ISA Marks: 80

Experiment wise Plan

List of experiments/jobs planned to meet the requirements of the course.

Category: Demonstration		Total Weightage: 20.00	
Expt./ Job No.	Experiment / Job Details	No. of Lab Session(s) per batch (estimate)	Marks / Experiment
1	Introduction to Safety guidelines & PLC and system wiring: Demo programs on Logic gates, switches and Pushbuttons.	1.00	5.00
2	Programming the PLC Via Ladder logic and structured text in TwinCAT Demo Programs on ALU ,Counter and timing functions	1.00	5.00
3	Demo on Electro Pneumatics : A. Time-dependent control of a double-acting cylinder with switch-on delay B. Sequential control of 2 double-acting cylinders with impulse valves in Automation studio.	1.00	5.00
4	Burglar Alarm: Consider the design of a burglar alarm for a house. When activated an alarm and lights will be activated to encourage the unwanted guest to leave. This alarm be activated if an unauthorized intruder is detected by window sensor and a motion detector. The window sensor is effectively a loop of wire that is a piece of thin metal foil that encircles the window. If the window is broken, the foil breaks breaking the conductor. This behaves like a normally closed switch. The motion sensor is designed so that when a person is detected the output will go on. As with any alarm an activate/deactivate switch is also needed.	1.00	5.00
5	Motor Control : A PLC motor controller has two START buttons and two STOP buttons. The motor is to run if two RUN buttons depressed simultaneously. The motor should run when the buttons are released. Motor stops by depressing any STOP button stops. Construct a LAD/structured text for this motor control task.	1.00	4.00
6	Sequential Logic Control using SCADA	1.00	4.00



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Department of Automation & Robotics

7	Develop a PLC program that will control a miniature set of traffic lights. These lights will go through a normal sequence, but will have pedestrian cross walk buttons that will activate a cross walk signal when pressed. When done the student should understand the design and implementation of time dependent control circuits.	1.00	4.00
8	To explore PID control: Write simple programs to read and output analog voltages from the PLC and perform PID control of a motor speed. Demonstrate it on TwinCAT.	1.00	4.00
9	Process controlled system in TwinCAT: A PLC-controlled system operates as follows. If the Start button is pressed, MV1 will be opened and dye starts to fill the tank. At the same time mixing-motor begins to run. As the level of the dye passes TBL2 and reaches to TBL1, MV1 will be closed and mixing-motor will stop. Then MV2 will be opened and dye begins to run out of the container. After the level of the dye reaches to the below of TBL2, MV2 will be closed. This process is repeated for two (2) times, then the system will stop. We can observe the stopping of the system with the lamp and the buzzer. After the system stops, buzzer will continue to run for 2 sec and then it stops. But the lamp continues to light until the reset button is pressed. When the reset button is pressed, the system will be ready to begin the same process again. Construct a LAD for this system.	1.00	4.00
10	To study Distributed Control System(DCS) programming using Function Block Diagram method	2.00	10.00
11	Exploring PLC Serial communication using Ethernet	2.00	10.00
	Learning Outcomes:		



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Department of Automation & Robotics

Semester: V

Year: 2019-20

Laboratory Title: Machine learning & ROS lab	Lab. Code: 18EARP301
Total Hours: 24	Duration of Exam: 2 hrs
Total Exam Marks: 100	Total ISA. Marks: 80

SL NO	List of Experiments
1	<i>Implement & demonstrate the creation of package in ROS, creation of ROS nodes & Execution of Publisher & Subscriber nodes for printing message.</i>
2	Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
3	For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
4	Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
5	Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
6	Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
7	Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.
8	Write a program to implement k-Nearest Neighbor algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.
9	<i>Implement project for solving real word problem statements using various tools such as WEKA, Matlab and perform the classification & regression analysis</i>
10	<i>Implement a Machine learning project using predictive, analysis, regression analysis, action analysis & statistical modeling, for automation and robotics applications.</i>



Laboratory Plan

FMTH0303-3.1

Semester: V

Year: 2021-2022

Laboratory Title: Mini project (Engineering Design Project)	Lab. Code: 18EARW301
Total Hours: 30	Duration of Exam: 2 hrs
Total Exam Marks: 50	Total ISA Marks: 50
Lab. Plan Author: Arunkumar C.Giriyapur	Date: 05-08-2021
Checked By: Mrs Shilpa Tanvashi	Date: 05-08-2021

Theme: *Product development through Engineering Design and Rapid Prototyping*

Course Objective: To apply engineering design process to develop a simple product and build it using rapid prototyping.

Task Details:

The project should include usage of engineering design principles, agile methodology and rapid prototyping. The product should be used to automate a process or perform a set of useful tasks.

Course Outcomes - CO

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

1. Carry out need analysis and identify suitable problems.
2. Apply the principles of engineering design to scope, plan and implement the project, continuously evaluate progress, navigate uncertainty and adversity, and iterate as needed.
3. Think critically while analyzing, evaluating, synthesizing, and applying diverse information and experiences to support decision-making during the design process.
4. Develop and apply creativity to generate novel ideas taking into account real constraints that lead to innovative outcomes.
5. Develop schematics and select appropriate components.
6. Prototype the product using rapid prototyping and test it.
7. Collaborate successfully with other team members to achieve the desired outcome.
8. Consider the individual, social and environmental impacts of their decisions to produce positive transformations while minimizing unintended consequences.
9. Communicate effectively through oral, written, and visual media and listen actively to comprehend the meaning of others.



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Experiment wise plan

List of activities planned to meet the requirements of the syllabus

Week No	Activities	Deliverables	ISA Marks out of 50
1&2	Need analysis, Identification of problem statement, Engineering Design process	Problem statement, Project plan, Process plan	10
3&4	Product development	Component designs & Integration, Modeling and simulation	10
5,6,7&8	Rapid prototyping, Testing and validation	Prototype (hardware and software)	20
9&10	Reporting	Test reports and Conclusion	10

Attributes for Final Evaluation of Mini project:

Sl. No	Activity	ESA Marks out of 50
1	Project Report	10
2	Poster & Paper Presentation	20
3	Demo of Project	10
4	Viva Voce(individual)	10
	Total Marks	50

Date:05-08-2021

Head of Department



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Department of Automation & Robotics

Course Content

Course Code: 18EARC308	Course Title: Hydraulics and Pneumatics	
L-T-P : : 4-0-0	Credits: 4	Contact Hrs: 50 hours
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50 hours		Exam Duration: 3 Hrs
Content		Hrs
Unit - 1		
Chapter No. 1. Introduction to Hydraulic Power and Hydraulic Pumps Pascal's law, Structure of Hydraulic Control System. The Source of Hydraulic Power: Pumps Pumping theory, pump classification, gear pumps, vane pumps, piston pumps, Variable displacement pumps, pump performance, pump selection. Problems on determining the pump flow rate, pump efficiency and pump power.		7hrs
Chapter No. 2. Hydraulic Actuators: Cylinders and Motors Linear Hydraulic Actuators (cylinders), Mechanics of Hydraulic Cylinder loading, Hydraulic Rotary Actuators, Gear motors, vane motors, piston motors, Hydraulic Motor Performance. Problems on determining motor speed, torque, power, motor efficiency		6hrs
Chapter No. 3. Hydraulic Valves Hydraulic Valves: Directional Control Valves- classification of directional control valves, direction control valves actuating devices, Symbolic representation as per ISO 1219 and ISO 5599, pressure control valves, flow control valves- classification of flow control valves, proportional control valves, and servo valves.		7hrs
Unit - 2		
Chapter No. 4. Hydraulic Circuit Design and Analysis Control of single acting and double acting Hydraulic Cylinder, regenerative circuit, pump unloading circuit, Double pump Hydraulic system, Counter Balance Valve application, Hydraulic cylinder sequencing circuits. Locked cylinder using pilot check valve, cylinder synchronizing circuits, Speed control of hydraulic cylinder: Meter-in circuit, Meter-out circuit and Bleed-off circuit, speed control of hydraulic motors. Ancillary Hydraulic Devices: Reservoirs, Accumulators, Pressure Intensifiers, Sealing Devices.		6hrs
Chapter No. 5. Pneumatic Systems Structure of Pneumatic control system, Choice of working medium, characteristics of compressed air, Pneumatic Actuators: Types of Linear Actuators or Pneumatic cylinders, Cylinder mountings, Cylinder seals, End cushioning in pneumatic cylinders. Pneumatic Control Valves: Direction control valve- types of direction control valves, ISO designation of direction control valves, Non return valves, methods of actuation of pneumatic directional control valves, Flow control valves, and Pressure control valves.		5hrs
Chapter No. 6. Pneumatic Circuit Design and Hydraulic Control Systems		9hrs



<p>Pneumatic Circuit Design: Direct and indirect control of single acting cylinder, control of single acting cylinder using “or” , “and”, “not” valve. Direct control of a double acting cylinder, Indirect control of double acting cylinder using memory valve, Supply air throttling and exhaust air throttling, Various methods of checking end position of a cylinder, Pressure dependent controls and Time dependent controls.</p> <p>Hydraulic Control Systems: Servo Control, Valve servo systems: Valve lap, mechanical feedback, systems response, electro hydraulic servo valves, Proportional valves: Force control, force position control, spool position control, proportional pressure control, proportional flow control, electrical control of proportional valve, Applications of proportional control valves.</p>	
Unit - 3	
<p>Chapter No. 7. Electro Pneumatics</p> <p>Basic electrical devices- Manually actuated push button switches, Limit switches, Pressure switches, Solenoids, Relays, Timers, Temperature switches, Direct and indirect control of single acting cylinders using electro pneumatics, Direct and indirect control of double acting cylinders using electro- pneumatics, Control of double acting cylinder OR logic (Parallel circuit), Control of double acting cylinder AND logic.</p>	5 hrs
<p>Chapter No. 8. Hydraulic System Maintenance</p> <p>Common faults in a hydraulic systems, contamination, Filter and filter maintenance, pump maintenance, Hydraulic system maintenance, fault diagnosis of Hydraulic system.</p>	5 hrs

Text Books (List of books as mentioned in the approved syllabus)

1. Anthony Esposito, Fluid Power with Applications, 6th Edition, Pearson, 2003.
2. Michael J. Pinches and John G. Ashby, Power Hydraulics, Prentice-Hall, 1989.

References

1. Herbert E. Merritt, Hydraulic Control Systems, John Wiley & Sons, 1967.
2. Peter J Chapple, Principles of Hydraulic System Design, 1st Edition ,Coxmoor Publishing Company, 2003.
3. S. R. Majumdar, Oil Hydraulic Systems, Tata McGraw Hill publishing Company Ltd, 2001.



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Course Content

Course Code: 17EARE301	Course Title: AI for Autonomous Robots	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration : 3 hours
Content		Hours
UNIT – 1		
Chapter 1: Introduction to Artificial intelligence and autonomous systems Foundation of artificial intelligence, robotics and the AI approach, Semi-autonomous control, Seven areas of AI, The Concept of Rationality The Nature of Environments, The Structure of Agents, Problem-Solving Agents, Searching for Solutions, Uninformed Search Strategies, Informed Search Strategies, Knowledge representation in AI, knowledge based agents, propositional logic, predicate calculus, inference rules		5hrs
Chapter 2: Robotic software architectures Subsumption architecture, Three-layer architecture, Pipeline architecture, Hierarchical Paradigm- Attributes of the Hierarchical Paradigm, Reactive Paradigm- Attributes of Reactive Paradigm , Hybrid Deliberative/Reactive Paradigm-Attributes of Hybrid Paradigm, Architectural Aspects, Managerial Architectures-Autonomous Robot Architecture (AuRA), Sensor Fusion Effects (SFX), State-Hierarchy Architectures, Model-Oriented Architectures, Interleaving Deliberation and Reactive Control.		5 hrs.
Chapter 3: Biological Foundations of the Reactive Paradigm Agency and computational theory , Animal Behaviors, Reflexive behaviors , Coordination and Control of Behaviors, Innate releasing mechanisms ,Concurrent behaviors ,Perception in Behaviors , Action-perception cycle ,Two functions of perception Gibson: Ecological approach , Neisser: Two perceptual systems , Schema Theory , Behaviors and schema theory , Principles and Issues in Transferring Insights to Robots		5 hrs
UNIT – 2		
Chapter 4: Capturing intelligence - Designing a reactive implementation with common sensing techniques for robotics perception Behaviors as Objects in OOP, Steps in Designing a Reactive Behavioral System, Case Study: Unmanned Ground Robotics Competition, Assemblages of Behaviors, Logical sensors, Behavioral Sensor Fusion, Designing a Sensor Suite, Proprioceptive Sensors, Proximity Sensors, Computer Vision, Range from Vision, Case Study: Hors d'Oeuvres, Anyone?		8 hrs
Chapter 5: Multi-agents and navigation in robotics Heterogeneity, Control, Cooperation, Emergent Social Behavior, Topological Path Planning, Relational Methods, Associative Methods, Case Study of Topological Navigation with a Hybrid Architecture		7 hrs
UNIT – 3		



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Chapter 6: Localization and Map Making Sonar Sensor Model, Bayesian, Conditional probabilities, Conditional probabilities, Updating with Bayes' rule, Dempster-Shafer Theory, Shafer belief functions Belief function for sonar Dempster's rule of combination Weight of conflict metric, HMM sonar model and Comparison of Methods, Example computations, Performance Errors due to observations from stationary robot, Tuning, Localization, Continuous localization and mapping, Feature-based localization Exploration, Frontier-based exploration, Generalized Voronoi graph methods.	6hrs
Chapter 7: Deep learning and natural language processing Deep Learning Improvement of the Deep Neural Network Vanishing Gradient Over fitting Computational Load. Language models, text classification, information retrieval	4 hrs

Text Book (List of books as mentioned in the approved syllabus)

1. Stuart J. Russell and Peter Norvig "Artificial Intelligence, A Modern Approach" Third Edition, Pearson Education, Inc. 2010
2. Robin R. Murphy "Introduction to AI Robotics", Second edition, The MIT Press Cambridge, Massachusetts, 2000

References

1. Elaine Rich, Kevin Knight: "Artificial Intelligence", 3rd Edition, Tata McGraw Hill, 2009, ISBN-10: 0070087709
2. Sebastian Thrun, Wolfram Burgard, Dieter Fox, "Probabilistic Robotics" MIT Press; Intelligent Robotics and Autonomous Agents series edition, 2005



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Department of Automation & Robotics

Course Content

Course Code: 15EARE302	Course Title: Computer vision and digital image processing	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration : 3 hours
Content		Hours
UNIT – 1		
CHAPTER 1: FUNDAMENTALS OF COMPUTER VISION AND DIGITAL IMAGE PROCESSING		6 hrs
Introduction to computer vision system, Geometric Camera Models- Pinhole Perspective, Cameras with Lenses, the Human Eye, Intrinsic and Extrinsic Parameters, Geometric Camera Calibration. Digital image processing system, application of computer vision and digital image processing. Design of machine vision system.		
CHAPTER 2: LIGHT AND SHADING, COLOR		6 hrs
Modeling Pixel Brightness, Reflection at Surfaces, Sources and Their Effects, the Lambertian+SpecularModel, Inference from Shading, Radiometric Calibration and High Dynamic Range Images, the Shape of specularities, Inferring Lightness and Illumination, Color-Human Color Perception, The Physics of color, representing Color, Inference from Color Finding specularities Using Color Shadow removal, using Color Constancy: Surface Color from Image Color.		
CHAPTER 3: IMAGE FORMATION AND PROCESSING		5 hrs
Image Acquisition – Sampling and Quantization- Pixel Relationships, image enhancement Spatial Domain Gray level Transformations Histogram Processing Spatial Filtering – Smoothing and Sharpening, Introduction to the Fourier Transform and the Frequency Domain, DFT, FFT.		
UNIT – 2		
CHAPTER 4: IMAGE SEGMENTATION AND FEATURE ANALYSI		6hrs
Detection of Discontinuities – Edge Operators – Edge Linking and Boundary Detection – Thresholding – Region Based Segmentation, A Model of the Image Degradation/Restoration Process, Noise Models, Restoration in the Presence of Noise Only–Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering		
CHAPTER 5: COLOR IMAGE PROCESSING AND IMAGE COMPRESSION		6hrs
Color Fundamentals, Color Models, Pseudo color Image Processing, Basics of Full-Color Image Processing Color Transformations, Smoothing and Sharpening, Color Segmentation, Noise in		



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Color Images Color Image Compression, Image Compression-Fundamentals, Image Compression Models, Elements of Information Theory, Error-Free Compression, Lossy Compression	
UNIT – 3	
CHAPTER 6: MORPHOLOGICAL PROCESSING Dilation and Erosion, Opening and Closing, The Hit-or-Miss Transformation, Some Basic Morphological Algorithms.	6hrs
CHAPTER 7: RECOGNITION AND BAYESIAN MODELING Object detection, Face recognition. Instance recognition, Category recognition, Context and scene understanding, Recognition databases and test sets, Prior models and Bayesian inference. Gradient descent and simulated annealing, Graph cuts, Markov random fields	5 hrs

Text Book (List of books as mentioned in the approved syllabus)

1. David A. Forsyth and Jean Ponce- Computer vision A modern approach, 2nd Edition, Pearson publication, 2003.
2. Rafael C. Gonzalez and Richard E. Woods- Digital Image Processing-2nd Edition, Prentice Hall publication, 2002

Reference book

1. Richard Szeliski , Computer Vision: Algorithms and Applications, Springer publication, 2010



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Course Content

Course Code: 16EARE301	Course Title: Power Electronics, Motors & Drives	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs
Content		Hrs
Unit - 1		
CHAPTER NO. 1. INTRODUCTION TO PE AND ELECTRIC DRIVE SYSTEMS - Power Electronics, Applications of Power Electronics, Types of Power Electronic Circuits, Peripheral Effects, Characteristics and Specifications of Switches. Basic components of an Electric drive system: Mechanical loads, electric motors, power sources, converters and controllers.		7
CHAPTER NO. 2. POWER DIODES, BJT, MOSFET AND RECTIFIERS: Introduction, Diode Characteristics, Reverse Recovery Characteristics, Power Diode Types, Freewheeling Diodes with Switched RL Load. Power BJT, structure of BJT, MOSFET and IGBT, characteristics of BJT, MOSFET and IGBT, comparison of power devices. Introduction, Single-Phase Full-Wave Rectifiers, Single-Phase Full-Wave Rectifier with RL Load, Single-Phase Full-Wave Rectifier with a Highly Inductive Load.		7
CHAPTER NO. 3. THYRISTORS AND COMMUTATION THEORY Introduction, Principle of Operation of SCR, Static Anode-Cathode Characteristics of SCR, two transistor model of SCR, Gate Characteristics of SCR, Firing circuits for SCRs, Turn-On Methods, Turn-Off Mechanism, Turn-Off. Natural and Forced Commutation – Class A and Class B types, Gate Trigger Circuit: Resistance Firing Circuit, Resistance capacitance firing circuit.		6
Unit - 2		
CHAPTER NO. 4. STATIC SWITCHES AND POWER SUPPLIES Single phase ac static switches, three phase ac static switches, three phase reversing switches, Solid state relays, Design of static switches, DC power supplies, DC Switched Mode DC power supplies, bidirectional power supplies, Switched Mode AC power supplies.		7
CHAPTER NO. 5. DC-DC CONVERTERS - Introduction, principle of step-down operation and its analysis with RL load, principle of step-up operation, Step-up converter with a resistive load, Performance parameters, Converter classification, Switching mode regulators: Buck regulator, Boost regulator, Buck-Boost Regulators.		7
CHAPTER NO. 6. POWER ELECTRONICS FOR MOTOR AND DRIVE APPLICATIONS DC and AC motor control, Single phase SCR drive, Three phase SCR drive, Reversible SCR drive, Speed control of DC motor, chopper-controlled DC drives, Microprocessor-Controlled DC drives, AC motor characteristics, speed control methods of induction motor, commutator less DC motor and Electronic commutation.		6
Unit - 3		
CHAPTER NO. 7. STEPPER MOTOR Principle of Stepper motor, Classification of Stepper motor, Principle of variable reluctance stepper motor, Principle of Permanent magnet stepper motor, Principle of hybrid stepper motor, driver for stepper motor, Applications of Stepper motor.		5
CHAPTER NO. 8. DRIVES FOR INDUSTRIAL APPLICATIONS Rolling mill drives, cement mill drives, electric traction drives, textile mill drives and machine tool drives.		5



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Text Book: (List of books as mentioned in the approved syllabus)

1. Gopal K Dubey, Fundamental of electric drives, Second, Narosa publication, 2005
2. P.S Bhimbhra, Power Electronics, Fourth, Khanna , 2007
3. Mohammed A Sharkawi, Fundamental of electric drives, Fourth, Brooks/Cole, 2000
4. Robert Boylestead and Louis Nashelsky "Electronic Devices and Circuit Theory, Eleventh edition, Pearson Publications
5. Rashid M H, Power Electronics Circuits, devices and applications, Second, PHI, 2000
6. P.C Sen, Power Electronics, Tata McGraw Hill, Ninth Edition.

References

1. P.S Bhimbhra, Power Electronics, Fourth, Khanna, 2007
2. Mohammed A Sharkawi, Fundamental of electric drives, Fourth, Brooks/Cole, 2000



Course Content

Course Code: 17EARE304	Course Title: Digital System Design and FPGA programming	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

Content	Hrs
Unit – 1	
Chapter No. 1. Review of Logic Design Fundamentals: Combinational logic, Boolean algebra and algebraic Simplification Karnaugh maps, designing with NAND and NOR gates, hazards in combinational circuits, flip-flops and latches, Mealy sequential circuit design, design of a Moore sequential circuit, equivalent states and reduction of state tables, sequential circuit timing, tristate logic and busses. Advanced Design Issues: Meta-stability, Noise Margins, Power, Fan-out, Timing Considerations, Brief overview of programmable logic devices, simple programmable logic devices (SPLDs), complex programmable logic devices (CPLDs), field-programmable gate arrays (FPGAs),	9 hrs
Chapter No. 2. Introduction to State Machine Charts and Microprogramming: State machine(SM) charts, derivation of SM charts, realization of SM charts, implementation of the dice game, microprogramming, Design Examples	6 hrs
Unit – 2	
Chapter No. 3. Designing with Field Programmable Gate Arrays: Implementing functions in FPGAs, implementing functions using Shannon's decomposition, carry chains in FPGAs, cascade chains in FPGAs, examples of logic blocks in commercial FPGAs, dedicated memory in FPGAs, dedicated multipliers in FPGAs, cost of programmability, FPGAs and One-Hot state assignment	7 hrs
Chapter No. 4. Modeling and design with HDL Basic Concepts, Dataflow Descriptions, Behavioral Descriptions, Structural Descriptions, Design examples, Timing and Delays, BCD to 7-Segment Display Decoder, BCD Adder, 32-Bit Adders, Traffic Light Controller, Shift-and-Add Multiplier, Array Multiplier. Introduction to Verilog and VHDL: Data Types, Modeling Concepts, Task and Functions, Specify Block and Timing Checks, Architecture study of popular FPGA families	8 hrs
Unit – 3	
Chapter No. 5. Testing and Verification What is Verification, what is a Test bench, The Importance of Verification, Convergence Model, What Is Being Verified, Functional Verification Approaches, Testing Versus Verification, Design and Verification Reuse, Cost of Verification	5 hrs
Chapter No. 6 Case studies on FPGA technologies in Automation and Robotics applications I. Robotic Car from Georgia Institute of Technology II. Robotic Controller: ASIC versus FPGA III. Expanding a robot's life: Low power object recognition via FPGA-based DCNN deployment IV. FPGA-powered parallel, pipelined vision algorithms	5 hrs



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Text Books (List of books as mentioned in the approved syllabus)

1. Charles Roth, Digital Systems Design using VHDL, 2/e, Cengage Learning, 2012.
2. Samir Palnitkar, Verilog HDL, 2/e, Pearson Education, 2013.
3. Charles Roth, Digital Systems Design using Verilog, Cengage Learning, 2014

References

1. John F. Wakerly, Digital Design Principles and Practices, 4/e, Pearson Education, 2013.
2. Michael Ciletti, Advanced Digital Design using Verilog HDL, 2/e, Prentice Hall Publications, 2012.
3. J. Bhasker, System Verilog HDL Primer, B.S. Publications, 2012.
4. J. Bhasker, Verilog Synthesis Primer, B. S. Publications, 2011.

3



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Laboratory Title: Hydraulics And Pneumatics Laboratory	Lab Code: 16EARP302
Total Contact Hours: 36	Duration of ESA Exam: 2 hrs
Total ISA Marks: 80	Total ESA Marks :20

List of Experiments

Sr No	Experiment Details	No. of Lab Session(s) per batch (estimate)
1	To study hydraulic pump, its characteristics and calculate the hydraulic power.	1
2	A. To study concepts of Meter-in and Meter-out circuits using Single-rod cylinder and 4/2 DCV B. Automation Studio Exercises- Create the given circuits and simulate them to investigate their operation in Automation Studio	1
3	To study pressure intensification of a single rod cylinder	1
4	Study of Hydraulic Motor with 4/3 DCV	
5	A. Study of indirect control of a double-acting cylinder with a pneumatically operated 5/2 directional control valve. B. Experiments on AND, OR, Latch and Electric limit Switch.	1
6	A. To study position dependent control of a double acting cylinder using mechanical limit switches. B. Verify the ladder diagram for AND, OR latch logic using 5/2 DCV and PLC kit..	1
7	To study the application of different center configuration of 4/3 DCV. (Tandem and closed centre)	1
8	Study of Speed Control of Single Acting Cylinder - Slow Speed Extension and Rapid Retraction.	1
9	Stop control, double-acting cylinder with 5/3 directional control valve, tensile load.	
10	To study the application of Regenerative Circuit	1
11	To familiarize the student with the use of a 2-way flow control valve	1
12	A. By using a 3/2 directional control valve with adjustable minimum pressure of response, a pressure-dependent (and in addition displacement) control of a double acting cylinder is put into effect. B. Clamping Camera Housings	1
13	The sequential control with two pneumatic drives. The signal overlapping occurring during this exercise is constructively solved by use of rollers with idle return. Practice is obtained in developing sequential diagrams and pneumatic circuit diagrams.	1
14	A double-acting cylinder is used to press together glued components. Upon pressing a push-button, the clamping cylinder is to extend and trip the roller valve. Once the fully extended position of the cylinder has been reached and sufficient clamping force has been developed, the cylinder is to retract to the initial position. Develop a control circuit using a pressure sequence valve.	1



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Lab. Code: 16EARP307	Laboratory Title: Real Time Embedded Systems Lab
Total Hours: 28	Duration of ESA Exam: 3hrs
Total ESA Marks: 20	Total ISA. Marks: 80

LIST OF EXERCISES & ISA COMPUTATION

Sl. No	EXPERIMENTS	MAX MARKS
1	Demo on Energia IDE and TM4C1294NCPDT, TIVA C series microcontroller board & Solving problems on Data Acquisition for Bio Medical / Process control/Industrial control application	05
2	Demo on Code Composer Studio(CCS) and TIVA C series TM4C1294NCPDT microcontroller board and problem solving on ADC,TIMERS,INTERRUPTS	05
3	Demo on LABVIEW on multitasking to implement Semaphores, Queue Demo on Introduction to Keil uvision 4 problem solving	05
4	Demo on Raspberry Pi Programming and peripheral programming	05
5	Exercises on basic RTOS program , RTX Kernel using peripherals like RTC, TIMERS , UART, SEMAPHORES	10
6	Exercises on implementing scheduling algorithms like Preemptive /Round Robin / Interrupts/ and Multitasking operations in RTX Kernel of Keil uvision 4.	10
7	Structured Query : Implementing Communication Protocols like I2C / SPI / UART /CAN / ETHERNET with Energia /CCS & TM4C1294 TIVA board	10
8	Study of real-time sensor data visualization in computational tool and triggering of power electronics devices.	05
9	Synopsis for ESA Project, Attendance & Timely Submission of document	05
	TOTAL ISA MARKS	80
ESA	Design using state machine architecture or Unified Modeling Language and implement solution for a real world problem using IOT technology for applications related Smart Home, Energy Management, Smart Grid, Smart Agriculture ,Wearable Device, Smart Health Care, Connected Car, Smart Machine involving Inter-process communication, Resource sharing and an effective scheduling technique satisfying real time constraints.	20
	TOTAL MARKS	100



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Lab. Code: 18EARP304	Laboratory Title: Mechatronics and Measurements Laboratory
Total Contact Hours: 22	Duration of ESA: 2 hrs
ISA Marks: 80	ESA Marks: 20

List of Experiments

Expt. No	List of Experiments	In Lab /Assignment
1	Demo of Quanser Mechatronics Sensor kit, DAQ card, DC Motor Control Trainer module, Inverted Pendulum Trainer module with NI ELVIS Platform.	In Lab
2	Investigation of time-response and frequency-response. i. Time-Response Identification of Resistor Capacitor (RC) Circuit. ii. Frequency-Response Identification of Resistor Capacitor (RC) Circuit iii. Control of a Resistor Capacitor (RC) Circuit iv. Investigation of time response of LRC Circuit Investigation of loading in circuits in series.	In Lab
3	Sensor characterization using sensor modules, namely, Accelerometer, Ultrasonic sensor, Temperature sensor, Strain gauge	In Lab
4	Sensor fusion of IMU and compass	In Lab
5	Model Based Design Experiments: i. Modeling Systems using Simulink. (Hydroplane) ii. System Identification of Disk Head Assembly. iii. Estimating Simulink model parameters from measured data. iv. System Analysis of Hydroplane.	In Lab
6	System identification of DC motor	In Lab
7	Control of an Inverted Pendulum on a Cart.	In Lab
8	Control of a Linear Electric Actuator	In Lab



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Laboratory Plan

FMTH0303-2.0

Semester: VI

Year: 2021

Laboratory Title: Minor project	Lab. Code: 17EARW302
Total Hours: 30	Duration of Exam: 3
Total SEE Marks: 50	Total CIE. Marks: 50
Lab. Plan Author: Prof. Arun C Giriyaapur	Date: 06/04/2021
Checked By: Dr Jyoti Bali	Date: 06/04/2021

Prerequisites:

Subjects learnt up to IV semester.

Theme: Mechatronics System Design

Objectives: i. To develop competency in mechatronics system design methodology.
ii. Design, develop, fabricate, implement & test - mechatronic systems using controllers, sensors and actuators.

Task Details:

The project should include mechatronics system design (hardware and software co-design), modeling and co-simulation using Matlab tools, Machine components design, Logic development, selection of controller, interfacing devices like robots, CNC machine tools with sensors and actuators.

Course Learning Objectives-CLO

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

1. Apply the principles of engineering design to plan and manage the project.
2. Gather the requirements, do functional analysis and develop specifications for a machine controller from the identified problem statement.
3. Develop alternative designs and choose the most suitable design for implementation.
4. Apply principles of mechatronics system design for hardware and software co-design as per standards (VDI 2206 & VDI 2221).
5. Develop elaborate validation and verification plans for each phase of the process.
6. Design control and signal conditioning circuits including schematics and wiring diagrams as per standards (IEC standards).
7. Build the Virtual prototype and validate using hardware-in-loop simulation and software-in-loop simulation.
8. Prototype the controller, deploy the software & Interface the controller to the machine.
9. Test, evaluate and improve the system.
10. Prepare technical report.



Design Process

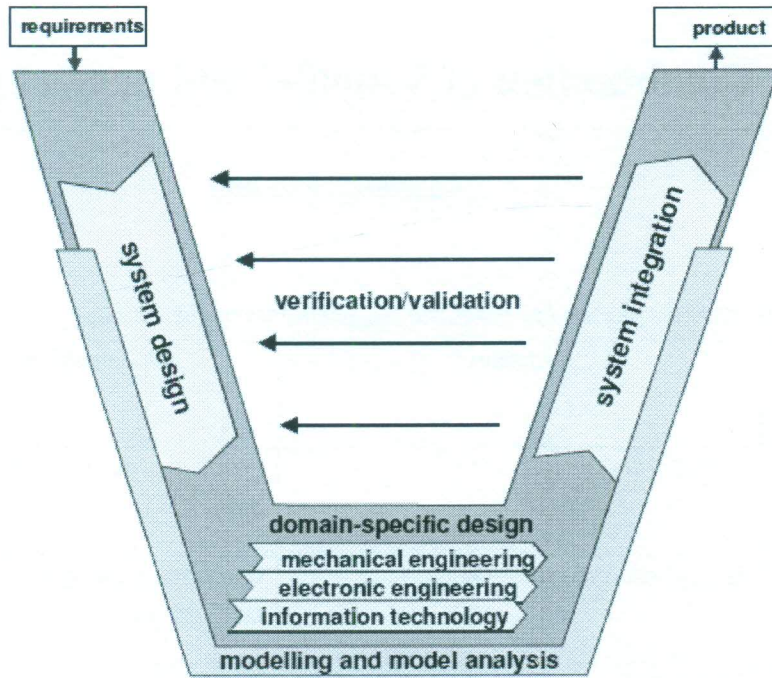
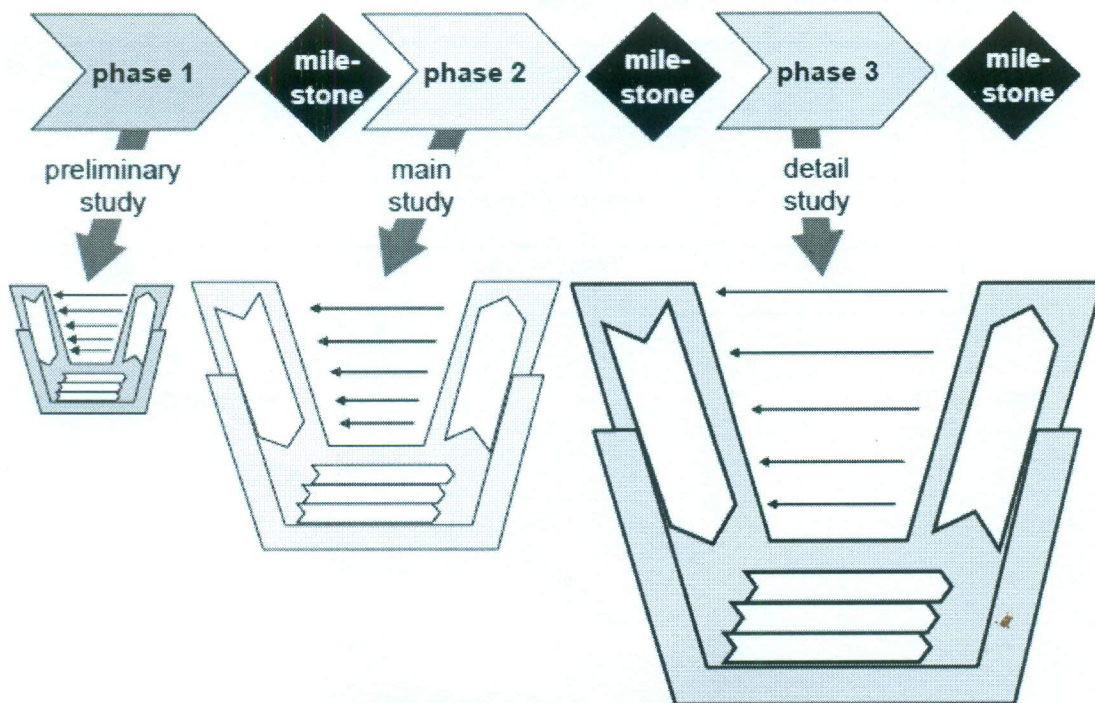


Figure 2. V-shaped model on the macro-level





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Combination of V-model and project plan

Experiment wise plan

1. List of activities planned to meet the requirements of the syllabus

Week No	Activities	Deliverables	CIE Marks out of 50
1&2	Engineering Design	Problem statement, Project plan	10
3&4	Mechatronics System Design	Component designs & Integration	10
5,6,7&8	Fabrication	Prototype	20
9&10	Testing, Validation an Improvements	Test reports and Recommendations	10

Attributes for Final Evaluation of Minor project:

Sl.No	Activity	SEE Marks out of 20
1	Project Report & Presentation	10
3	Demo of Project	10
	Total Marks	20

Date: 06/04/2021

Head of Department



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**B.E. (Automation & Robotics)
Curriculum Structure & Syllabus
2020 – 24 Batch**



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Semester: III

Course Code	Course Title	Category						Marks	
			L	T	P	Hrs	Credits	ISA	ESA
			15EMAB201	Statistics And Integral Transforms	BS	4	0	0	4
15EMAB231	Calculus And Integral Transforms								
18EARC201	Analog & Digital Electronic Circuits	ES	4	0	0	4	4	50	50
19EARC202	Kinematics of Machinery	PSC	4	0	0	4	4	50	50
18EARC203	Data Structure Algorithm Design and Analysis	PSC	4	1	0	6	5	50	50
18EARC204	Mechanics Of Materials	ES	3	0	0	3	3	50	50
18EARC205	Manufacturing Technology	PSC	3	0	0	3	3	50	50
18EARP201	Analog & Digital Electronic Circuits Lab	PSC	0	0	1	2	1	80	20
18EARP202	Kinematics Of Machinery lab	PSC	0	0	1	2	1	80	20
19EARP203	Machine Drawing Lab	PSC	0	0	1	2	1	80	20
Total			22	1	3	30	26		

ISA: Internal Semester Assessment, **ESA:** End Semester Assessment, **L:** Lecture **T:** Tutorials,

P: Practical, **PSC:** Program Scheme Core, **HSC:** Humanities Scheme Core, **BS:** Basic Science



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Semester: IV

Course Code	Course Title	Category						Marks	
			L	T	P	Hrs	Credits	ISA	ESA
15EMAB206	Numerical Methods and Partial differential equations	BS	4	0	0	4	4	50	50
15EMAB241	Vector calculus and differential								
18EARC206	Machine Design	PSC	3	0	0	3	3	50	50
19EARC207	Control Systems	PSC	4	0	0	4	4	50	50
18EARC208	Microcontrollers Programming & Interfacing	PSC	4	0	0	4	4	50	50
19EARC209	Object Oriented Programming & DBMS	PSC	4	0	0	4	4	50	50
18EARC210	Robot Analysis & Design	PSC	4	0	0	4	4	50	50
16EARP205	Manufacturing & Metrology lab	PSC	0	0	1	2	1	80	20
18EARP208	Microcontrollers Programming & Interfacing Lab	PSC	0	0	1	2	1	80	20
19EARP209	Object Oriented Programming & DBMS Lab	PSC	0	0	1	2	1	80	20
Total			23	0	3	29	26		

ISA: Internal Semester Assessment, **ESA:** End Semester Assessment, **L:** Lecture **T:** Tutorials,

P: Practical, **PSC:** Program Scheme Core, **HSC:** Humanities Scheme Core, **BS:** Basic Science



Semester: III

Course Content

Course Code: 18EARC201		Course Title: Analog and Digital Electronic Circuits	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 50	
ISA Marks: 50	ESA Marks: 50	Total Marks: 100	
Teaching Hrs: 50		Duration of ESA: 3 hrs	
Content			Hrs
Unit - 1			
1.0 Modeling and Analysis of electrical circuits The Lumped Circuit Abstraction, Modeling Physical Elements using lumped circuit abstraction, Signal Representation, Dependent Sources and the Control Concept, Network theorems: The Node Method, Loop Method, Superposition, Thévenin's Theorem and Norton's Theorem, Applications.			7
2.0 Basics of Digital Electronics Number Representation , MOSFET Switch Implementation of Logic Gates, The SR Model of the MOSFET, Active Pull-ups, Voltage Levels and the Static Discipline, Simplifying Logic Expressions using K-map, Combinational circuits: encoder/decoder, multiplexers/de-multiplexers , Binary adder/subtractor, Binary comparator, Sequential Circuits: Gated D Latch, JK Flip-Flop, Registers, Counters, Application examples			7
3.0 Transistors Operating point, Fixed bias circuits, Emitter stabilized biased circuits, Voltage divider biased, Bias stabilization, BJT transistor modeling, , Emitter follower, CB configuration, Collector feedback configuration, analysis of CE configuration using h- parameter model; Relationship between h-parameter model of CE,CC and CB configuration.			6
Unit - 2			
4.0 Operational Amplifiers Device properties of the Operational Amplifier, Simple Op Amp Circuits: The Non-Inverting Op Amp, The Inverting Connection, A Special Case: The Voltage Follower, Op Amp RC Circuits: Op Amp Integrator, Op Amp Differentiator, An RC Active Filter, The RC Active Filter Impedance Analysis, Sallen-Key Filter, Op Amp in Saturation: Op Amp Integrator in Saturation, Positive Feedback : RC Oscillator.			7
5.0 Printed Circuit Board (PCB) Design Issues Partitioning , Resistance Of Conductors , "Kelvin Feedback" , Ground Noise And Ground Loops , Ground Isolation Techniques , Static PCB Effects , Inductance , Parasitic Effects In Inductors ,Capacitive Noise And Faraday Shields , Buffering ADCs against Logic Noise, Skin Effect , Transmission Lines , Basic Linear Design, Decoupling Mixed Signals ICs With Low Digital Content, Sampling Clock Considerations , Mixed Signal Grounding, Grounding DSPs with Internal Phase-Locked Loops, Decoupling ,Ringing , Thermal Management, Data Converter Thermal Considerations			7
6.0 First Order Transients in Linear Electrical Circuits Analysis of RC & RL circuits, Propagation Delays, State and State variables, Problems			6
Unit - 3			
7.0 Energy and Power in Digital Circuits Energy Storage Elements; capacitors and inductors , Power and Energy Relations for a Simple RC Circuit, Average Power in an RC Circuit, Power Dissipation in Logic Gates: Static Power Dissipation, Total Power Dissipation, CMOS Logic Gate Design.			5
8.0 Transients in Second Order Circuits Undriven Series RLC circuit, Stored Energy in Transient Series RLC circuit, Undriven Parallel RLC circuit, Driven Parallel RLC circuit, State Space Analysis			5



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Text Books:

1. Anant Agarwal , Foundations of Analog and Digital Electronic Circuits, 1, Morgan Kau, 2005
2. Thomas L. Floyd, Digital fundamentals, 9, Pearson Ed, 2006
3. Robert L. Boylestad, Electronic Devices and Circuit Theory, 10, Pearson Ed, 2008



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Course Content

Course Code: 19EARC202		Course Title: Kinematics of Machinery	
L-T-P: 4-0-0		Credits: 4	Contact Hrs.: 50
ISA Marks: 50		ESA Marks: 50	Total Marks: 100
Teaching Hrs.: 50			Exam Duration: 3 Hrs.
UNIT - I			
No	Content	Hrs	
1	INTRODUCTION TO KINEMATICS The subject of Kinematics and Dynamics of Machines, Kinematics and Dynamics as Part of the Design Process, Is It a Machine, a Mechanism, or a Structure? Examples of Mechanisms; Terminology, Mobility of Mechanisms, Kinematic Inversion, Grashof's Law for a Four-Bar Linkage.	5	
2	POSITION ANALYSIS Kinematic Requirements in Design, The Process of Kinematic Analysis, Kinematic Analysis of the Slider-Crank Mechanism, Solutions of Loop-Closure Equations, Applications to Simple Mechanisms, Applications to Compound Mechanisms, Trajectory of a Point on a Mechanism.	7	
3	VELOCITY & ACCELERATION ANALYSIS Velocity Vector, Equations for Velocities, Applications to Simple Mechanisms, Applications to Compound Mechanisms. Acceleration Vector, Equations for Accelerations, Applications to Simple Mechanisms, Applications to Compound Mechanisms.	8	
UNIT - II			
4	STATIC FORCE ANALYSIS Forces, Moments and Torques, Laws of Motion, Free-Body Diagrams, Drawing a Free-Body Diagram, Characterizing Contact Forces, Static Equilibrium, Analysis of a Two-Force Member, Sliding Friction Force.	6	
5	CAMS: DESIGN AND KINEMATIC ANALYSIS Types of Cam, Types of Followers, Prescribed follower motion, Follower motion schemes, Graphical disk cam profile design, Pressure angle, Design Limitations, Analytical disk cam profile design.	7	
6	GEARS: KINEMATIC ANALYSIS AND SELECTION Types of gears, spur gear terminology, involute tooth profiles, spur gear kinematics, rack and pinion kinematics, gear trains, idler gears, planetary gear trains.	7	
UNIT - III			



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7	BELTS AND CHAIN DRIVES Types of Belt, Belt drive geometry, Belt drive kinematics, Types of Chains, Chain drive geometry, Chain drive kinematics.	5
8	SCREW MECHANISMS Thread features, Thread forms, Ball screws, Lead Screw kinematics, Screw forces and torques, Differential screws, Auger screws.	5

TEXT BOOKS:

1. Fundamentals of Kinematics and Dynamics of Machines and Mechanism, Oleg Vinogradov, CRC Press-2000.
2. Machines and Mechanisms-Applied Kinematic Analysis, David H. Myszka, Fourth Edition, Pearson Education.

REFERENCE:

1. Kinematics, Dynamics and Design of Machinery, Kenneth J. Waldron, Wiley India Pvt Ltd; Second edition.



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Course Content

Course Code: 18EARC203	Course Title: Data structures ,Algorithm design and analysis	
L-T-P : 4-1-0	Credits: 4	Contact Hrs: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 03 hours

Content	Hrs
Unit - 1	
Chapter 1: GENERAL PROBLEM SOLVING CONCEPTS- Problem Solving in Everyday Life, Types of Problems, Problem Solving with Computers - Problem Definition, Solution Design & Refinement, Testing Strategy Development, Program Coding and Testing, Using the Problem Solving Method, Break-Out Diagrams, Difficulties with Problem Solving. How the Computer Stores Data, Functions-function prototypes, Operators, Expressions and Equations.	6 hrs
Chapter 2: DESIGN AND ANALYSIS OF ALGORITHMS- Algorithms and Their Representations, Modifying Algorithms, Review of Asymptotic Notations, Mathematical Analysis of Non-Recursive and Recursive Algorithms, Brute Force Approaches: Introduction, Selection Sort and Bubble Sort, Sequential Search and Brute Force String Matching , Divide and Conquer: General Method, Defective Chess Board, Binary Search, Merge Sort, Quick Sort and its performance.	7 hrs
Chapter 3: ARRAYS, STACKS & QUEUES: Arrays, Dynamically Allocated Arrays, , Polynomials, Sparse Matrices, Representation of Multidimensional Arrays, Structures and Unions, Stacks, Stacks Using Dynamic Arrays, Queues, Circular Queues, Evaluation of Expressions, Queues, Single- and Double-Ended Priority Queues.	7 hrs
Unit - 2	
Chapter 4: LINKED LISTS, TREES &GRAPHS: Singly Linked lists and Chains, Representing Chains in C, Linked Stacks and Queues, Polynomials, Additional List operations, Sparse Matrices, Doubly Linked Lists. Introduction, Binary Trees, Binary Tree Traversals, Graph representation, Adjacency matrix, Adjancey list, Application of graphs.	8 hrs
Chapter 5:DYNAMIC PROGRAMMING & GREEDY METHOD: Depth First Search and Breadth First Search, The General Method, Warshall's Algorithm, Floyd's Algorithm for the All-Pairs Shortest Paths Problem, Single-Source Shortest Paths, The Traveling Salesperson problem, Kruskal's algorithm, Huffman trees.	7 hrs
Unit - 3	
Chapter 6: INTRODUCTION TO C++: Overview of C++, Sample C++ program, Different data types, operators, expressions, and statements, arrays and strings, pointers & user defined types. Class Specification, Class Objects, Scope resolution operator, Access members, Defining member functions, Data hiding, Constructors, Destructors, Parameterized constructors,	8 hrs
Chapter 7:BASIC OOP CONCEPTS: Base Class, Inheritance and protected members, Protected base class inheritance, Inheriting multiple base classes, Virtual function, Calling a Virtual function through a base class reference, Virtual attribute is inherited, and Virtual functions are hierarchical, Pure virtual functions, Abstract classes, Using virtual functions.	7 hrs



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Text Books (List of books as mentioned in the approved syllabus)

1. Maureen Sprankle, Jim Hubbard: "PROBLEM SOLVING & PROGRAMMING CONCEPTS", Pearson Publications, 9th edition, 2012.
2. AnanyLevitin: Introduction to The Design & Analysis of Algorithms, 2nd Edition, Pearson Education, 2007.
3. Horowitz, Sahni, Anderson-Freed: Fundamentals of Data Structures in C, 2nd Edition, Universities Press, 2007.
4. Herbert Schildt: The Complete Reference C++, 4th Edition, Tata McGraw Hill, 2003.

References

1. Yedidyah, Rubenstein, Tannenbaum: Data Structures Using C and C++, 2nd Edition, Pearson Education, 2003.
2. Thomas H. Cormen, Charles E. Leiserson, Ronal L. Rivest, Clifford Stein: Introduction to Algorithms, 3rd Edition, PHI, 2010.



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Course Content

Course Code: 18EARC204	Course Title: Mechanics of Materials	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs
Content		Hrs
Unit - 1		
Chapter No. 1. Stress & Strain Introduction, Normal Stress Under Axial Loading, Direct Shear Stress, Bearing Stress, Stresses on Inclined Sections, Equality of Shear Stresses on Perpendicular Planes, Strain, Displacement, Deformation, and the Concept of Strain, Normal Strain, Shear Strain		5
Chapter No. 2. Mechanical Properties of Materials The Tension Test, The Stress-Strain Diagram, Hooke's Law, Poisson's Ratio, Design Concepts, Types of Loads, Safety, Allowable Stress Design, Load and Resistance Factor Design		5
Chapter No. 3. Axial Deformation Introduction, Saint-Venant's Principle, Deformations in Axially Loaded Bars, Deformations in a System of Axially Loaded Bars, Statically Indeterminate Axially Loaded Members		5
Unit - 2		
Chapter No. 4. Torsion Introduction, Torsional Shear Strain, Torsional Shear Stress, Stresses on Oblique Planes, Torsional Deformations, Torsion Sign Conventions, Power Transmission, Statically Indeterminate Torsion Members.		5
Chapter No. 5. Equilibrium of Beams Introduction, Shear and Moment in Beams, Graphical Method for Constructing Shear and Moment Diagrams, Discontinuity Functions to Represent Load, Shear, and Moment		5
Chapter No. 6. Bending Introduction, Flexural Strains, Normal Stresses in Beams, Analysis of Bending Stresses in Beams, Introductory Beam Design for Strength, Flexural Stresses in Beams of Two Materials, Bending Due to Eccentric Axial Load, Un symmetric Bending		5
Unit - 3		
Chapter No. 7. Shear Stress in Beams Introduction, Resultant Forces Produced by Bending Stresses, The Shear Stress Formula, The First Moment of Area Q, Shear Stresses in Beams of Rectangular Cross Section, Shear Stresses in Beams of Circular Cross Section.		5
Chapter No. 8. Beam Deflections Introduction, Moment-Curvature Relationship, The Differential Equation of the Elastic Curve, Deflections by Integration of a Moment Equation, Deflections by Integration of Shear-Force or Load Equations, Deflections Using Discontinuity Functions		5



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Text Books (List of books as mentioned in the approved syllabus)

Timothy .A. Philpot, Mechanics of Materials , An Integrated Learning System, Third edition, Wiley.

References

Roy R., Craig, JR. Mechanics of Materials, Third edition, JOHN WILEY & SONS



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Course Content

Course Code: 18EARC205	Course Title: Manufacturing Technology	
L-T-P: 3-0-0	Credits: 4	Contact Hrs: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs
Content		Hrs
Unit - 1		
Chapter No. 1. Turning , Shaping and Planing Machines Classification, constructional features of Lathe, Shaping Machine, Planing Machine. Driving mechanisms of Lathe, Shaping and Planing machines. Different operations on Lathe, Shaping Machine & Planing Machine. Cutting tools. Simple problems on machining time calculations.		7
Chapter No. 2. Milling Machines Classification, constructional features of milling machines. Types of milling cutters & milling cutter nomenclature. Milling processes, up milling and down milling concepts. Various milling operations. Indexing: Simple, compound, differential and angular indexing. Simple problems on simple and compound indexing		7
Chapter No. 3. Drilling & Grinding Machines Classification, constructional features of drilling machine & related operations. Types of drill & drill bit nomenclature, drill materials. Types of abrasives, Grain size, bonding process, grade and structure of grinding wheels, grinding wheel types. Classification, constructional features of grinding machines (Center less, cylindrical and surface grinding). Selection of grinding wheel, dressing and truing of grinding wheels. Analysis of the grinding process.		6
Unit - 2		
Chapter No. 4. CNC Machine Tools Introduction to CNC machines- Principles of operation. Axes of CNC machine-Coordinate systems. Elements of CNC machines, Basics of Manual part programming methods.		7
Chapter No. 5. Nontraditional Machining Need for nontraditional machining, principle, equipment & operation of Abrasive Jet Machining, Water Jet Machining, Electro-Chemical Machining, Electrical Discharge Machining, Wire EDM, Electron Beam Machining, Laser Beam Machining & Plasma Arc Machining		7
Chapter No. 6. Metrology and Inspection Definition, need of inspection, terminologies, methods of measurement. Standards of measurement-line standards, end standards & wavelength standards. Limits, fits & gauges-introduction, tolerances, limits of size, fit and tolerances, Limit gauges classification.		6
Unit - 3		
Chapter No. 7. Comparators and Angular Measurement Devices Characteristics of comparators, classification of comparators- Mechanical, Electrical & Pneumatic comparators. Introduction to angular measurement - Vernier & optical Bevel Protractor, sine bar, sine centre, angle gauges.		5
Chapter No. 8. Advanced Metrology Introduction & applications of: Co-ordinate Measuring Machine-important features of CMM, possible causes of errors in CMM, Performance, applications & advantages of CMM. Universal Measuring Machine- comparison of CMM & UMM, inspection on UMM. Precision instruments based on laser –		5



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principle- laser interferometer- application in linear, angular measurements

Text Books (List of books as mentioned in the approved syllabus)

1. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes and Systems, 4th Edition, John Wiley & Sons Inc, 2010.
2. R.K.Jain, Engineering Metrology, Khanna Publishers, 2009.

References

1. □R.K.Jain, Production Technology, Khanna Publications, 2003.
2. □HMT, Production Technology, Tata Mc Graw Hill, 2001.
3. S .K. Hajra & Choudhury, Elements of workshop technology, volume -II Machine Tools, 13th Edition, Media Promoters & Publishers Pvt Ltd.



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Lab. Code: 18EARP201	Laboratory Title: Analog and Digital Electronic Circuits Laboratory
Total Contact Hours: 22	Duration of ESA: 3 hrs
ISA Marks: 80	ESA Marks: 20

List of Experiments

Sr No	Exercise Details
1	a) Study and demonstrate of Components and measuring equipment's during course of ADC Laboratory. b) Study and Demonstration of Diode Characteristics c) Demonstration and Construction of Rectifiers
2	a) Demonstration and Construction of Clipping Circuits b) Demonstration and Construction of Clamping Circuits c) Zener diode as voltage regulator d) Linear Voltage regulators – Positive and Negative e) Characteristics of resonant circuits
3	a) Verification of Network Theorems b) Analyze the operation of MOSFET during switching Theorems
4	a) Construction of operational amplifier b) Construction of simple DAC circuit with 0-10V output voltage c) Construction of an 8-bit ADC circuit that utilizes LEDs to indicate its binary output value.
5	a) Construction of Logic Gates b) Construction of Adders and Subtractors
6	Construction of Conversions
7	Construction of Multivibrators
8	Construction of Flip-Flops



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List of Experiments

<i>Laboratory Title:</i> Kinematics of Machinery lab	Lab. Code: 18EARP202
<i>Total Hours:</i> 28	<i>Duration of Exam:</i> 3 hrs.
<i>ISA Marks:</i> 80	<i>ESA. Marks:</i> 20

Sr No	List of Exercise Details
1	Introduction to Mat lab
2	Introduction to Multibody Simulation
3	Visualizing Co-ordinate frames
4	Simple Pendulum
5	Double Pendulum
6	Pendulum on cart
7	Crane Base
8	Pendulum waves
9	Four bar linkage
10	Inline -Three Engine
11	Crank & Flywheel
12	Importing CAD model in Mat lab
13	Project



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Department of Automation & Robotics

Laboratory Title: Machine Drawing Laboratory	Lab Code: 19EARP203
Total Contact Hours: 36	Duration of ESA Exam: 2 hrs
Total ISA Marks: 80	Total ESA Marks :20

List of Exercises

Sr No	Exercise Details	No. of Lab Session(s) per batch (estimate)
1	Free Hand Sketching	1
2	Geometric Dimensioning and Tolerancing and Isometric Drawing	1
3	Introduction to Solidworks Software	1
4	Part Modeling & Drafting	2
5	Assembly	1
6	Kinematic Analysis	1
7	Finite Element Analysis	1
8	Solidworks Routing	1
9	Solidworks Sustainability	1
10	Project Work	2



Semester: IV

Course Content

Course Code: 18EARC206		Course Title: Machine Design	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 40	
ISA Marks: 50	ESA Marks: 50	Total Marks: 100	
Teaching Hrs: 40		Duration of ESA: 3 hrs	
Content			Hrs
Unit - 1			
Chapter No. 1. THE DESIGN PROCESS			5
Introduction, Materials in Design, The Evolution of Engineering Materials, The Evolution of Materials in Products, the Design Process, Types of Design, Design Tools and Materials Data, Function, Material, Shape, and Process.			
Chapter No. 2. MATERIAL PROPERTY CHARTS			5
Exploring Material Properties, Modulus–density chart Strength–density chart, Modulus–strength chart, Maximum service temperature chart, Cost bar charts, The modulus–relative cost chart, and The strength–relative cost chart.			
ENGINEERING MATERIALS, THEIR PROPERTIES AND MATERIAL SELECTION			
The Families of Engineering Materials, Materials Information for Design, Material Properties and Units.			
Chapter No. 3. KINEMATICS OF GEARS AND GEAR DESIGN			5
Spur Gear Geometry: Involute-Tooth Form, Interference Between Mating Spur Gear Teeth, Devising Gear Trains, Forces, Torque And Power In Gearing, Gear Manufacture, Gear Quality, Allowable Stress Numbers, Stresses In Gear Teeth, Selection Of Gear Material Based On Bending Stress, Design Of Spur Gears, Power-Transmitting Capacity, Practical Considerations For Gears And Interfaces With Other Elements. Forces and stresses on helical gear teeth, design of helical gears, bearing forces on shafts carrying bevel gears, bending moments on shafts carrying bevel gears, design of bevel gears for pitting resistance, forces, friction, and efficiency in worm gear sets, stress in worm gear teeth, surface durability of worm gear drives.			
Unit - 2			
Chapter No. 4. KEYS, COUPLINGS, SEALS AND SHAFT DESIGNS			5
Materials for keys, stress analysis to determine key length, other methods of fastening elements to shafts, couplings, universal joints, retaining rings and other means of axial location, types of seals, seal materials, shaft design procedure, forces exerted on shafts by machine elements, stress concentrations in shafts, design stresses for shafts, shafts in bending and torsion only, shaft design example, recommended basic sizes for shafts, shaft rigidity and dynamic considerations, flexible shafts			
Chapter No. 5. LINEAR MOTION ELEMENTS, SPRINGS, FASTNERS			5
Power screws, ball screws, application considerations for power screws and ball screws, bolt materials and strength, externally applied force on a bolted joint, thread stripping strength, other means of fastening and joining. Kinds of springs, helical compression springs, stresses and deflection for helical compression springs, analysis of spring characteristics, design of helical compression springs, helical torsion springs,			



improving spring performance by shot peening, spring manufacturing.	
Chapter No. 6. CLUTCHES AND BRAKES Descriptions of clutches and brakes, types of friction clutches and brakes, performance parameters, time required accelerating a load, inertia of a system referred to the clutch shaft speed, effective inertia for bodies moving linearly, energy absorption: heat-dissipation requirements, response time, friction materials and coefficient of friction, plate-type clutch or brake.	5
Unit - 3	
Chapter No. 7. BEARINGS: ROLLING CONTACT & SURFACE CONTACT Types of rolling contact bearings, thrust bearings, mounted bearings, bearing materials, load/life relationship, design life, bearing selection: radial loads only, bearing selection: radial and thrust loads combined, mounting of bearings, tapered roller bearings, practical considerations in the application of bearings, importance of oil film thickness in bearings, life prediction under varying loads.	5
Chapter No. 8. MACHINE FRAMES, BOLTED CONNECTIONS AND WELDED JOINTS Machine frames and structures, recommended deflection limits, design to resist bending, design of members to resist torsion, eccentrically loaded bolted joints, types of joints, types of welds, size of weld, method of treating weld as a line, welded joints.	5

Text Book (List of books as mentioned in the approved syllabus)

1. Robert L. Norton, Machine Design, Pearson Education edition, Prentice Hall, 2005
2. Robert L. Mott, Machine Elements in Mechanical Design, Fourth edition, PEARSON Prentice Hall, 2004

References

1. Shigley J.E. and Mischke C.R, Mechanical Engineering Design, McGraw Hill Publication Co. Ltd
2. Michael F. Ashby, Materials Selection in Mechanical Design, Fourth Edition, 2014, 2014
3. Michael F. Ashby, Materials Selection in Mechanical Design, Fourth Edition, 2014, 2014



Course Content

Course Code: 19EARC207	Course Title: Control Systems	
L-T-P : 4-0-0	Credits: 4	Contact Hrs: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 Hrs
Content		Hrs
Unit - 1		
Chapter No. 1. Introduction to Control Systems and System Modeling in Frequency domain System Configurations (open-loop & closed loop systems), Analysis and Design Objectives, The Design Process. Mathematical modeling of physical Systems: Transfer function, Electrical networks, Mechanical systems, Transfer Functions for Systems with Gears, Electromechanical System Transfer Functions, Analogous systems, Block diagram representation and reduction, Signal flow graph representation and reduction using Mason's Gain formula.		8
Chapter No. 2. Time Response Introduction, Poles, Zeros, and System Response, Standard test signals, First-order system response to step, ramp and impulse inputs, Second-order system response to step input; Un-damped, Under damped, Critical damped and Over damped systems. Time response specifications of first and second order systems, Analysis and Design of Feedback Systems, Steady state errors and error constants.		8
Chapter No. 3. Controllers Introduction, Proportional control, Integral Control, Proportional Plus Integral (P-I) Control, Proportional Plus Derivative (P-D) Control, Proportional-Integral-Derivative (PID) control, Guideline for selection of controller mode.		4
Unit - 2		
Chapter No. 4. Stability Analysis Concepts of stability, Necessary conditions for Stability, Routh-Hurwitz Criterion, Routh-Hurwitz Criterion: Special Cases.		5
Chapter No. 5: Root Locus Techniques Defining the Root locus, General rules for constructing root loci, Sketching the Root locus, Effect of gain adjustment, addition of pole and addition of zero on system response and system stability.		5
Chapter No. 6 : Frequency Domain Analysis Introduction, Stability analysis, Bode plot and Nyquist plot to obtain phase margin and gain margin of a given system.		10
Unit - 3		
Chapter No. 7 : Design Via Frequency Response		5



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Transient Response via Gain Adjustment, Lag Compensation, Lead Compensation, Lag-Lead Compensation.	
Chapter No. 8: Modeling in the Time Domain (State Space) General State-Space Representation, Applying the State-Space Representation, Converting a Transfer Function to State Space, Converting from State Space to a Transfer Function.	5

Text Books (List of books as mentioned in the approved syllabus)

1. Norman S. Nise, "Control Systems Engineering", John Wiley & Sons, Inc, Sixth edition, 2011.

References

1. Benjamin C. Kuo, Automatic Control Systems, PHI, 7th edition.
2. K. Ogata "Modern Control Engineering", Pearson Education Asia/ PHI, 4th Edition, 2002.



Course Content

Course Code: 18EARC208		Course Title: Microcontrollers Programming & Interfacing	
L-T-P: 4-0-0		Credits:4	Contact Hrs: 4
ISA Marks: 50		ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50			Exam Duration: 100
Unit I			
No	Content		Hrs
1	Chapter 1: Introduction to Microcontroller Introduction To Microprocessor and Microcontroller: History and Evolution, types of microprocessors, Difference between Microprocessors and Microcontrollers. CPU architectures: RISC/CISC and Harvard/Von-Neumann, Overview of PIC Microcontroller family, Introduction to different microcontroller families (8051, ATMEL/AVR, and ARM).		5
2	Chapter 2: PIC Microcontroller Architecture and assembly language programming Architecture and pin functions, Registers and Instructions, Data formats and directives, Introduction to assembly language programming, Program counter and program ROM space. Branch, Call and Time delay loop: Branch instructions and looping, Call instruction and stack, Time delay instructions and pipeline. Timing diagrams.		7
3	Chapter 3: I/O Port programming I/O port programming, I/O bit manipulation programming, Arithmetic, logic instructions and programs: Arithmetic instructions, Signed number concepts and arithmetic operations, logic and compare instructions, rotate instructions and data serialization, BCD and ASCII conversion.		8
Unit II			
4	Chapter 4: PIC and AVR programming in C Data types and time delays in C, I/O programming, logic operations, data serialization, program ROM allocation, Program ROM allocation in C18, State diagrams, Timing diagrams in-depth.		5
5	Chapter 5: Timer and Serial port programming Programming TIMERS 0 and 1, counter programming, Programming TIMER0 and 1 in C, Basics of serial communications, PIC18 connection to RS232, PIC18 serial port programming in assembly and C		8
6	Chapter 6: Interrupt programming in Assembly and C Polling Vs interrupts, PIC18 Interrupts, Programming timer interrupts, programming external hardware interrupts, programming the serial communication interrupt, PortB change interrupts. ADC, DAC and sensor interfacing: ADC characteristics, ADC programming in the PIC18, DAC interfacing, sensor interfacing and signal interfacing.		7
Unit – III			
7	Chapter 7: Introduction to the STMicroelectronics Line of Microcontrollers STM Nucleo Boards, STM32CubeMX Application: Pinout Tab, MCU Alternative Functions, Integrated Peripheral (IP) Tree Pane, Creating a Project using CubeMX, ARM Cortex Microcontroller Software Interface Standard, Memory-Mapped Peripherals, Core Memory Addresses, Peripheral Memory Addresses, HAL GPIO Module		5
8	Chapter 8: Interrupts and Timers: Interrupts, NVIC Specifications, Interrupt Process, External Interrupts, Interrupt Demonstration, STM Timer Peripherals STM Timer Configuration, Update Event Calculation, Polled or Non-interrupt Blink LED Timer Demonstration, Test Run: Interrupt-Driven Blink LED Timer Demonstration, Test Run: Multi-rate Interrupt-Driven Blink LED Timer Demonstration		5



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Text Book

Mazidi & Mazidi, "PIC Microcontroller and Embedded systems", Pearson Edition

Mazidi & Mazidi, "Introduction to AVR Microcontroller and Embedded systems", Pearson Edition

Donald Norris, "Programming with STM32 getting started with Nucleo board and C/C++", McGraw-Hill Education

Reference Books

Ramesh Gaonkar, Fundamentals of microcontrollers and Applications in Embedded Systems. Penram International Publishing(India) Pvt. Ltd.

Ajay V Deshmukh, "Microcontroller: Theory and Applications"

M Krishnakumar, "Microprocessors and Microcontrollers".



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Course Content

Course Code: 19EARC209	Course Title: Object Oriented Programming and Database Management Systems	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs
Content		Hrs
UNIT I		
Chapter 1. Fundamental concepts of object oriented programming: Introduction to the principles of object-oriented programming ,classes, objects, messages, encapsulation, inheritance, polymorphism, exception handling, and object-oriented containers, Access Specifiers, Member Functions, Instance of a Class, Default Constructors, Destructors, Accessing Data Fields, Constructors with Parameters, Static Class Members, - Data Members and Member Functions		8
Chapter 2. Object-Oriented Programming - I Inheritance, Derived Class, Calling the Base Class Constructor, Overriding Member Functions, Polymorphism, Class Inheritance Hierarchies, Revisiting Class Diagrams, Abstract Classes, Run-Time Information, Early vs. Late Binding, Virtual Base Classes, Multiple Inheritance, Interfaces, Scope Resolution Operator, Nested Classes, Local Classes, Passing Objects to Functions, Return Objects, Object Assignment, Friend Function, Operator Overloading, Function Overloading, Copy Constructors.		8
Chapter 3 : Object-Oriented Programming-II Data types, program control, Functions, Numerical Computations in Python - NumPy arrays, SciPy for numerical methods, Data plotting with Matplotlib, Statistical modelling in Python -Pandas for DataFrame, SciPy and statsmodels for basic statistical data analysis, Image Processing in Python scikit-image, filtering, edge detection.		6
UNIT II		
Chapter 4:SDLC models, Object oriented analysis and structural modeling SDLC Models-waterfall model,v-model,spiral model and agile model, Requirement Engineering, System Modelling, UML and SysML Walkthrough, Class Diagram, Use Case Diagram, State Chart Diagram, Activity Diagram, Sequence Diagram.		8
Chapter 5 Introduction to database management system Introduction to DBMS and an example, Characteristics of Database approach; Actors On and Behind the Scene; Advantages and Disadvantages of using DBMS; Data models, schema and instances; Three-schema architecture and data independence; Database languages and interfaces; The database system environment.		8
Chapter 6: Data Models Using High-Level Conceptual Data Models for Database Design; An Example Database Application; Entity Types, Entity Sets, Attributes and Keys; Relationship types, Relationship Sets. Roles and Structural Constraints; Weak Entity Types; Refining the ER Design; Relationship types of degree higher than two; ER Diagrams, Naming Conventions and Design Issues		6



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UNIT III	
Chapter No 7: Relational Database design and structured query language Relational Model Concepts; Relational Model Constraints and Relational Database Schemas; Update Operations, SQL Data Definition and Data Types; Specifying basic constraints in SQL, Insert, Delete and Update statements in SQL; Specifying constraints as Assertion and Trigger; Views in SQL; Basic queries in SQL	5
Chapter No 8 Normalization Informal Design Guidelines for Relation Schemas; Functional Dependencies; Normal Forms Based on Primary Keys; General Definitions of Second and Third Normal Forms; Boyce-Codd Normal Form.	5

Text Books (List of books as mentioned in the approved syllabus)

1. Herbert Schildt, "C++: The Complete Reference", Tata McGraw-Hill, 2003.
2. Allen B. Downey "Think Python" First Edition, Green Tea Press, 2011
3. Ian Sommerville, "Software Engineering," Pearson Publication, 9th edition, 2010.
4. Grady Booch, James Rumbaugh and Ivar Jacobson, "Unified Modeling Language User Guide," Addison-Wesley, 1999.
5. Ramez Elmasri and Shamkant B. Navathe, "Fundamentals of Database Systems," Pearson Education, 5th edition, 2008.

Reference Books:

1. Ramakrishnan S. and Gehrke J: "Database Management Systems", 3rd edition, McGraw Hill, 2007
2. R. S. Pressman, "Software Engineering – A practitioner's approach", 3rd ed., McGraw Hill Int. Ed
3. Mark Lutz Programming Python, 4th Edition, O'Reilly Media, Inc., December 2010



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Course Content

Course Code: 18EARC210	Course Title: Robot Analysis & Design	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Duration of ESA: 3 Hrs

UNIT - I

No	Content	Hrs
1	Introduction to Robotics and Applications Introduction, Classifications of Robots, Robot Components, Robot Degrees of Freedom, Robot Joints, Robot Coordinates, Robot Reference Frames, Programming Modes, Robot Characteristics, Robot Workspace, Robot Languages, and Robot Applications. Representing Position and Orientation Coordinate frames, representing Pose in 2-Dimensions, representing Pose in 3-Dimensions, representing Orientation in 3-Dimensions, orthonormal Rotation Matrix, three-Angle Representations, combining Translation and Orientation.	6
2	Position Analysis of Serial Manipulators Describing a Robot Arm, Link Parameters and Link Coordinate systems, Homogeneous transformation Matrices, Denavit-Hartenberg, Forward Kinematics, Inverse Kinematics, A 2-Link Robot, A 6-Axis Robot.	8
3	Jacobian Analysis of Serial Manipulators Different Kinematics of rigid body, Different Kinematics of serial manipulators, screw coordinates and screw systems, Manipulator Jacobian Matrix, conventional Jacobian, Screw-Based Jacobian, and Transformations of screw coordinates. Relationship Between Two Methods, condition number, singularity analysis.	6

UNIT - II

4	Statics and Dynamics of Serial Manipulators Types of gears/ motor/ drives/ encoders, Motion controller (Motion control software), Statics of Serial Manipulators, Transformations of Forces and Moments, mass properties, momentum, transformation of inertia matrix, kinetic energy. Newton-Euler Laws, Recursive Newton-Euler Formulation	6
5	Trajectory planning Path versus Trajectory, Joint-Space versus Cartesian-Space Descriptions, Basics of Trajectory Planning, Joint-Space Trajectory Planning, Third-Order Polynomial Trajectory Planning, Fifth-Order Polynomial Trajectory Planning, Linear Segments with Parabolic Blends, Linear Segments with Parabolic Blends and Via Points, Higher-Order Trajectories, Other Trajectories, Cartesian-Space Trajectories, Continuous Trajectory Recording.	7
6	Wrist Mechanisms Introduction, Bevel-Gear Wrist Mechanisms, structure representation of mechanisms, structure characteristics of epicyclic Gear Drives, Kinematics of Robotic Wrist Mechanisms, and static force analysis.	7

UNIT - III

7	Tendon-Driven Manipulators Introduction, classification of Tendon-Driven Manipulators, Planar Schematic Representation, Kinematics of Tendon-Driven Manipulators, Static Force Analysis, Feasible Structure Matrices, Redundant forces resolution.	5
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8	Robot End-Effectors Classification of End-Effectors, Drive system for Grippers, Mechanical Grippers, Magnetic Grippers, Vacuum Grippers, Adhesive Grippers, Hooks, Scoops and Special gripper, Advanced grippers , Gripper Force Analysis & gripper design.	5
TEXT BOOKS: <ul style="list-style-type: none">• Saeed B. Niku, "Introduction to Robotics, Analysis, Systems, Applications, PHI Learning private limited. 2009.• S K Saha, "Introduction to Robotics", McGraw – Hill Education, 2008.• Peter Corke, "Robotics, Vision and Control: Fundamental Algorithms In MATLAB® Second, Completely Revised, Extended And Updated Edition, Springer, 2017• Lung-Wen Tsai, "Robot Analysis", A Wiley-Interscience Publications, John Wiley & Sons, Inc., 1999.		
REFERENCE: <ul style="list-style-type: none">• Fu K.S., Gonzalez R.C., and Lee C.S.G., "Robotics control, Sensing, Vision and Intelligence", McGraw-Hill Book Co.,• Groover M.P., "Industrial Robotics, programming and applications ", McGraw-Hill Book Co., 1995.• Ashitava Ghoshal, "Robotics Fundamental Concepts & Analysis", Oxford University Press.• John J. Craig, "Introduction to Robotics-Mechanics & Control", Pearson Education, Inc., 2005.• T. Bajd, M. Mihelj, J. Lenarcic, A. Stanovnik, M. Munih., "Robotics", Springer, Vol 43.		



KLE Technological
University

Creating Value
Leveraging Knowledge

B. V. Bhoomaraddi College Campus, Vidyanagar, Hubballi - 580031. Karnataka (India)
Department of Automation & Robotics

Semester: IV

Year: 2020

Laboratory Title: Manufacturing & Metrology Laboratory	Lab Code: 16EARP205
Total Contact Hours: 36	Duration of ESA Exam: 2 hrs
Total ISA Marks: 80	Total ESA Marks :20

List of Exercises

Sr No	Exercise Details	No. of Lab Session(s) per batch (estimate)
1	Demonstration of machining operations like facing, turning, taper turning, knurling & thread cutting on a work piece using Lathe Machine.	2
2	Demonstration and performing of side and face milling operations on a given work piece using a Milling Machine	1
3	Demonstration and performing of operations like drilling of holes on a given work piece using a Drilling Machine.	1
4	Calibration of Vernier caliper & Micrometer screw gauge.	1
5	Measurement of angle using Sine Bar.	1
6	Demonstration of working principle of Co-ordinate Measuring Machine (CMM).	1
7	Demonstration of 3D printer.	1
8	Machining parts of the XY positioning table on the milling machine.	2
9	Drilling & tapping on required parts of the XY positioning table.	1
10	Assembly of the XY positioning table.	1



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B. V. Bhoomaraddi College Campus, Vidyanagar, Hubballi - 580031. Karnataka (India)
Department of Automation & Robotics

Lab. Code: 18EARP208	Laboratory Title: Microcontrollers Programming & Interfacing Lab
Total Contact Hours: 22	Duration of ESA: 2 hrs
ISA Marks: 80	ESA Marks: 20

List of Experiments

Experiment No.	Experiment/Exercise Title
1	Write a program to demonstrate the blinking of LED in PIC16F877A and Arduino board.
2	Write a program to demonstrate a counting machine which count from 0000 to 9999 and display on 7 segment LED display using PIC16F877A and Arduino board.
3	Write a program to read the values from the temperature sensor (LM35) and display the temperature in degree Celsius on LCD display using PIC16F877A and Arduino board
4	In bank lockers there is requiremen of password protection to open the locker. Develop an application Using a 4*3 keypad and LCD to secure the lockers by providing password protection.
5	Write a program to measure the distance of an object using ultrasonic Sensors and display the distance in terms of centimeters and inches. Make the connections as per the schematic and develop the flowchart and the code to perform the required operation
6	Write a program to control the speed and direction of DC, stepper and servo motors.
7	Design a development board using Atmega328 or PIC 18 using eagle/ Dip-trace
8	Develop a printed circuit board (PCB) for your designed Atmega328 or PIC18 development board.
9	Design a programmer for your PIC18 development board to burn the program using PICkit2 or any similar software's
10	Develop a printed circuit board (PCB) for your designed and validated programmer which can burn programs on the PIC16 or PIC18 ICs.
11	Write a program on Pyboard microcontroller using python programming and image processing to detect the tennis ball.



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B. V. Bhoomaraddi College Campus, Vidyanagar, Hubballi - 580031. Karnataka (India)
Department of Automation & Robotics

Lab. Code: 19EARP209	Laboratory Title: Object Oriented System Design Laboratory
Total Contact Hours: 22	Duration of ESA: 2 hrs
ISA Marks: 80	ESA Marks: 20

List of Experiments

Sr NO	Exercise Details
1	Write a C++ program to find the sum of individual digits of a positive integer. b) Write a C++ program to generate the first n terms of the sequence
2	a) Write a C++ program to sort a list of numbers in ascending order. b) Write a Program to illustrate New and Delete Keywords for dynamic memory allocation
3	Write a C++ program using class to process shopping list for a departmental store. The list include details such as the code number and price of each item and perform the operations like adding, deleting items to the list and printing the total value of a order
4	Write a python program to create a list and perform the following methods 1) insert() 2) remove() 3) append() 4) len() 5) pop() 6) clear()
5	write a python program to create a menu with the following options 1. to perform addition 2. to perform subtraction 3. to perform multiplication 4. to perform division accepts users input and perform the operation accordingly
6	Write a python program to concatenate the data frames with two different objects
7	Execute SQL queries on - group by, having clauses and aggregate functions on a given database to retrieve the required data
8	Design a database for the given specifications & implement the database and write and execute the queries for the given statements.
9	Design a database for the given schema using normalization concept and write and execute the SQL statements for given queries
10	Implement a project using object oriented language, for automation and robotics applications. (FOR SEE)

Desapex Engineering Consultants LLP

Jayanagar, Bangalore

Mail: shreedhar@desapex.com

Phone: +91-8217658157

www.desapex.com



MAY 28, 2022

To whomsoever it may concern

This is to certify that **Ms. Ayesha Nagnoor (USN 01FE18BAR012)** was a **Digital Engineering intern** at our organisation from **January 2022 to May 2022**.

During this period at the organization, we found her to be hard working and a quick learner. We wish her all the success in her future endeavours.

This letter has been issued on her request on completion of the internship.

Desapex

Yours Sincerely,

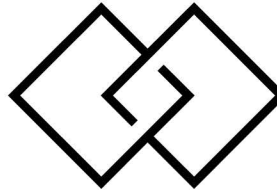


Shreedhar Hungund

Desapex Engineering Consultants LLP



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KLE Tech.
CASE
Center for Automation Systems Engineering

CERTIFICATE OF INTERNSHIP

This certifies that

Bhumika A. Kulkarni

has completed a Training and Project work in

Tyre Wear Measurement System - VRL Logistics Ltd.

at KLE Tech's Center for Automation Systems Engineering (CASE), for the period of 6 Months
starting from January 2022.

A handwritten signature in blue ink, appearing to read 'Arun C. Giriya Pur'.

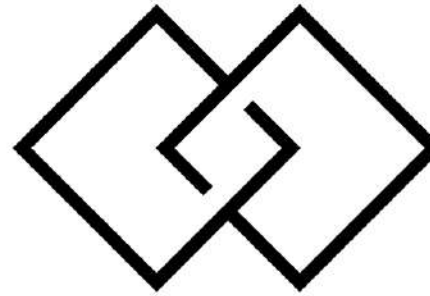
ARUN C. GIRIYAPUR
Administrator

A handwritten signature in blue ink, appearing to read 'Kartik Lakamanhalli'.

KARTIK LAKAMANHALLI
Manager, Systems Engineering



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KLE Tech.
CASE
Center for Automation Systems Engineering

CERTIFICATE OF INTERNSHIP

This certifies that

Ranjeet R. Shingade

has completed a Training and Project work in **Welding Robot - VRL Logistics Ltd.**
at KLE Tech's Center for Automation Systems Engineering (CASE),
for the period of 6 Months starting from January 2022.

ARUN C. GIRIYAPUR
Administrator

KARTIK LAKAMANHALLI
Manager, Systems Engineering

17th June 2022

TO WHOM SO EVER IT MAY CONCERN

This is to certify that **Ms. Samatha V** from KLE Technological University has completed "Internship" on "Geared Motor Test Jig with Rated Load" from 10.01.2022 to 17.06.2022 She was guided by Mr. Sriram H.S, Manager - Process Engineering. We wish her success in all her future endeavors.

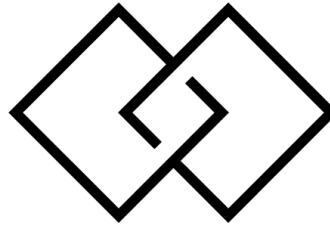
Skandray Technologies Ltd



Chief Operating Officer



KLE Technological
University
Creating Value
Leveraging Knowledge



KLE Tech.
CASE
Center for Automation Systems Engineering

CERTIFICATE OF INTERNSHIP

This certifies that

Shreyas B. N

has completed a Training and Project work in

Autonomous Mobile Robot with Manipulator - VRL Logistics Ltd.

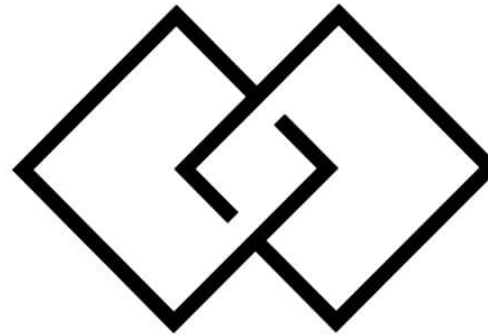
at KLE Tech's Center for Automation Systems Engineering (CASE), for the period of 6 Months
starting from January 2022.

ARUN C. GIRIYAPUR
Administrator

KARTIK LAKAMANHALLI
Manager, Systems Engineering



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KLE Tech.
CASE
Center for Automation Systems Engineering

CERTIFICATE OF INTERNSHIP

This certifies that

Ganesh Reddy

has completed a Training and Project work in

Autonomous Mobile Robot with Manipulator - VRL Logistics Ltd.

at KLE Tech's Center for Automation Systems Engineering (CASE), for the period of 6 Months
starting from January 2022.

A handwritten signature in blue ink, appearing to read 'Arun C. Giriya Pur'.

ARUN C. GIRIYAPUR
Administrator

A handwritten signature in blue ink, appearing to read 'Kartik Lakamanhalli'.

KARTIK LAKAMANHALLI
Manager, Systems Engineering



08th July 2022

CERTIFICATE

This is to certify the project work on “**Synthetic eCal generation framework – based on physical camera modelling and aligned vehicle dynamics**” which was carried out by **Ms. Amogha T S** (Student ID: 01FE18BAR006), a bona fide student of KLE Technological University, Hubballi, Karnataka from **10th January 2022 to 8^h July 2022.**

The work was carried under the supervision of **Mr. Soumen Bhowmick, Manager - AM CE ENG.** This project was completed in line with the defined requirement. During the above training period with us, we found Ms. Amogha T S to be sincere, hardworking and result oriented.

We wish her all the success in his future endeavors and career ahead.

A handwritten signature in blue ink that reads "Mamta Joshi". The signature is written in a cursive style and is underlined with a long horizontal stroke.

Mamta Joshi

Head HR - Technical Center India

Continental Automotive Components (India) Pvt. Ltd.
Sattva South Gate Tech Park, Plot No.1, Veerasandra Industrial Area,
Hosur Main Road, Bangalore 560 100

Phone +91 80 6679 1300
Corporate Identity No. U72900KA2007PTC043146
GSTIN: 29AAKCS9578C1ZP
www.continental.com

Regd. Office: Plot No.53B, Bommasandra Industrial Area, Hosur Road, Attibele Hobli, Anekal Taluk, Bangalore -560099, India

31st May 2022

To Whomsoever It May Concern

This is to certify that Miss. Anjali Chavan was associated with HDASquare Industries private Limited from 10th January 2022 to 31st May 2022 as a Student Trainee Intern.

In the course of the internship Anjali Chavan had worked with SQUAROTIX - business vertical of HDASquare Industries private Limited on the following topic:

- **Study and Development of Smart Basket**

During the internship period Anjali Chavan had shown sincere and dedicated attitude in carrying out tasks.

We wish you all the best for your future endeavours.

Thanking You,

From HDASquare Industries Private Limited.



Aniket Zende

Project Manager



Ashish Patil

HR Manager



Durvankur Sankpal

Managing Director

31st May 2022

To Whomsoever It May Concern

This is to certify that Miss. Dakshaja Inamdar was associated with HDASquare Industries private Limited from 10th January 2022 to 31st May 2022 as a Student Trainee Intern.

In the course of the internship Dakshaja Inamdar had worked with SQUAROTIX - business vertical of HDASquare Industries private Limited on the following topic:

- **Study and Development of Smart Basket**

During the internship period Dakshaja Inamdar had shown sincere and dedicated attitude in carrying out tasks.

We wish you all the best for your future endeavours.

Thanking You,

From HDASquare Industries Private Limited.



Aniket Zende

Project Manager



Ashish Patil

HR Manager



Durvankur Sankpal

Managing Director

31st May 2022

To Whomsoever It May Concern

This is to certify that Mr. Shubham Mahajan was associated with HDASquare Industries private Limited from 10th January 2022 to 31st May 2022 as a Student Trainee Intern.

In the course of the internship Shubham Mahajan had worked with SQUAROTIX - business vertical of HDASquare Industries private Limited on the following topic:

- **Study and Development of Smart Basket**

During the internship period Shubham Mahajan had shown sincere and dedicated attitude in carrying out tasks.

We wish you all the best for your future endeavours.

Thanking You,

From HDASquare Industries Private Limited.



Aniket Zende

Project Manager



Ashish Patil

HR Manager



Durvankur Sankpal

Managing Director

L&T-TS HR/99007753

18 May 2022

Mr.Shubham Mugali

INTERNSHIP CERTIFICATE

This has reference to your Completion of Internship under Genesis Programme in L&T Technology Services Limited (LTTS).

Relevant details of internship during the tenure with LTTS are as under.

INTERNSHIP ID : 99007753
INTERNSHIP START DATE : 1 February 2022
INTERNSHIP END DATE : 13 May 2022
LOCATION : Mysore

We wish you success in your future endeavours.

Yours Sincerely,
For L&T Technology Services Limited,



Ashwin J
Senior Manager – HR Employee Relations & Compliance



15th June 2022

CERTIFICATE

This is to certify that Ms. Laxmi Shashikant Kole - student of automation robotics, KLE Institute of technology has successfully completed six month long internship at Technicious Technology Services Pvt Ltd. During her internship she was part of the Team which was responsible for developing HIMS system.

✓ Project: Healthcare Information Management System

Technologies Used: Django(Python Framework, React Js)

The candidate was found to be enthusiastic, hardworking and a quick learner during her short stint at Technicious Technology Services. Her performance has been assessed as excellent.

We wish her every success in her life and career.

For Technicious Technology Services private Ltd.

Sabareesan Sankaran

Director

Technicious Technology Services

R.S No 182/5 A-7, Evergreen homes, Nagala Park, Kolhapur, Maharashtra - 416003

To whom it may concern

This is to certify that Mr. Poornaditya Mishra has completed his internship training and project with us at Nymble Labs from 10 January 2022 to 3 June 2022.

During the course of his internship, he was found to be diligent and hard-working and demonstrated sheer focus and dedication to his work. He understood the assignments quickly and was sincere and attentive during the training as well as during his project.

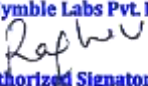
His project area revolved mainly around the domain of robotics and systems engineering. His project and training allowed him to gain an in-depth knowledge followed by hand-on learning in the following domains, and many more:

- System design and optimisation
- System validation and verification
- Industry standards for system tests
- Understanding the structure of PCBs and circuits
- Creating schematics and PCBs from the schematics
- Time management and teamwork
- Implementation of Agile methodology and OKRs

His association with us was very fruitful and we wish him the best for his future endeavors.

Thank you

For and on behalf of Nymble Labs Private Limited

For Nymble Labs Pvt. Ltd.

Authorized Signatory

Raghav Gupta
Chief Executive Officer
Nymble Labs Private Limited

CERTIFICATE OF INTERNSHIP

This is to certify that Mr. Kolli Venkata Siva Sai Prathyush has undergone Internship with Difacto Robotics and Automation Pvt Ltd from the 17th January 2022 to 25th May 2022.

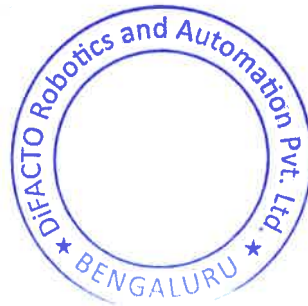
As part of the In-Plant Training, he underwent the following:

1. Basic about PLC Hardware and its component
 - Introduction to Mitsubishi PLC
 - Study and selection of Electrical components
 - Hands-on experience – PLC programming in Q & FX series
 - Configuring Mitsubishi Servo drive parameters
 - Configuring Area Scanner & Magnetic Sensor
2. Understanding the
 - Basics of PLC programming (GXWORKS2) & (GX WORKS3)
 - Basics of Servo Drives
 - HMI Screen Design (J MOBILE Studio 4.0)
 - Electrical Drawing (ARES STANDARD)
3. Understanding the basics of Mobile Robot Solution addressing the various industrial Processes.
4. Participate for Programming of AGV Error band logic and PID trials

Sincerely,

For DiFACTO Robotics and Automation Pvt. Ltd.,

Air Cmde Sudhakar KS (Retd)
General Manager – Corporate Functions





Ref No: HR/TRG/SI-DWD/21-22/007

25.05.2022

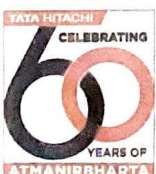
To Whom So Ever It May Concern

This is to certify that Mr. Punit Mahajan (**USN: 01FE18BAR029**) a student of final year B.E Automation & Robotics at KLE Technological University, Hubli, has successfully completed his internship at our Plant from 10.01.2022 to 10.05.2022 under the guidance of Mr. Sachin Hunashikatti & submitted a project report on "Migration from Manual Tightening to Automation".

His overall performance and conduct during the internship was **Very Good**.

We wish him all success for the future.

HRD

**Tata Hitachi Construction Machinery Company Private Limited**

(Formerly Known as Tata Hitachi Construction Machinery Company Limited)

Block No.2, KIADB, Belur Industrial Estate, Garag Road, Mummigatti, Dharwad - 580011 INDIA

Telephone : +91 836 2432777 2432555

Registered Office: Jubilee Building | 45 Museum Road | Bengaluru 560 025 India | Telephone +91 80 66953301 02 03 04 05

CIN: U85110KA1998PTC024588 | Email: info@tatahitachi.co.in

Website: www.tatahitachi.co.in |

Desapex Engineering Consultants LLP

Jayanagar, Bangalore

Mail: shreedhar@desapex.com

Phone: +91-8217658157

www.desapex.com



MAY 28, 2022

To whomsoever it may concern

This is to certify that **Ms. Rohini Jangalagi (USN 01FE18BAR059)** was a **Digital Engineering intern** at our organisation from **January 2022 to May 2022**.

During this period at the organization, we found her to be hard working and a quick learner. We wish her all the success in her future endeavours.

This letter has been issued on her request on completion of the internship.

Desapex

Yours Sincerely,



Shreedhar Hungund

Desapex Engineering Consultants LLP

Desapex Engineering Consultants LLP

Jayanagar, Bangalore

Mail: shreedhar@desapex.com

Phone: +91-8217658157

www.desapex.com



MAY 28, 2022

To whomsoever it may concern

This is to certify that **Ms. Rohini Jangalagi (USN 01FE18BAR059)** was a **Digital Engineering intern** at our organisation from **January 2022 to May 2022**.

During this period at the organization, we found her to be hard working and a quick learner. We wish her all the success in her future endeavours.

This letter has been issued on her request on completion of the internship.

Desapex

Yours Sincerely,



Shreedhar Hungund

Desapex Engineering Consultants LLP

Desapex Engineering Consultants LLP

Jayanagar, Bangalore

Mail: shreedhar@desapex.com

Phone: +91-8217658157

www.desapex.com



MAY 28, 2022

To whomsoever it may concern

This is to certify that **Ms. Sahana C Phatarpekar (USN 01FE18BAR034)** was a **Digital Engineering intern** at our organisation from **January 2022 to May 2022**.

During this period at the organization, we found her to be hard working and a quick learner. We wish her all the success in her future endeavours.

This letter has been issued on her request on completion of the internship.

Desapex

Yours Sincerely,



Shreedhar Hungund

Desapex Engineering Consultants LLP

26 May 2022

CERTIFICATE

This is to certify that Miss Ulfath Jahan (USN No. 01FEI8BAR056) a student of VIII Semester, BE Automation and Robotics from KLE Technological University,Hubbali has successfully completed her in-plant training/project in our organization during 07.02.2022 to 26.05.2022 on the topic of the project is “**Auto grinding and finishing**”.

We wish all the best for her future endeavors.

For Kirloskar Ferrous Industries Limited



Santibhusan Das

Senior Manager-Training & Development

E2WAY PRIVATE LIMITED™

10-3/45, Satya Sai Krupa Garden, Vithal Nagar, Gulberga, Karnataka, India Pin: -585102 Email: - e2waypvtltd@gmail.com

Date: 10/06/2022

TO WHOMSOEVER IT MAY CONCERN

This is to certify that Bhagya patil has completed her internship and training in Electric two wheeler at E2way Private Limited, Kalaburgi, from 10/01/2022 to 10/06/2022.

She has worked on a project title Electrification of an ICE two wheeler. This project was aimed at converting existing ICE two wheeler into electric two wheelers.

During his/her internship/training she has demonstrated her skills with self-motivation to learn new skills. Her performance exceeded our expectations and she was able to complete the project on time.

We wish her all the best for his/her upcoming career.

E2way Private Limited

Director

Prajwal Kulkarni

E2WAY PRIVATE LIMITEDTM

10-3/45, Satya Sai Krupa Garden, Vithal Nagar, Gulbarga, Karnataka, India Pin: -585102 Email: - e2waypvtltd@gmail.com

Date: 10/06/2022

TO WHOMSOEVER IT MAY CONCERN

This is to certify that Prasanna Reddy has completed his internship and training in Electric two wheeler at E2way Private Limited, Kalaburgi, from 10/01/2022 to 10/06/2022.

He has worked on a project title Electrification of an ICE two wheeler. This project was aimed at converting existing ICE two wheeler into electric two wheelers.

During his internship/training he has demonstrated his skills with self-motivation to learn new skills. His performance exceeded our expectations and he was able to complete the project on time.

We wish him all the best for his/her upcoming career.

E2way Private Limited

Director

Prajwal Kulkarni

E2WAY PRIVATE LIMITEDTM

10-3/45, Satya Sai Krupa Garden, Vithal Nagar, Gulbarga, Karnataka, India Pin: -585102 Email: - e2waypvtltd@gmail.com

Date: 10/06/2022

TO WHOMSOEVER IT MAY CONCERN

This is to certify that Shreedhar Reddy has completed his internship and training in Electric two wheeler at E2way Private Limited, Kalaburgi, from 10/01/2022 to 10/06/2022.

He has worked on a project title Electrification of an ICE two wheeler. This project was aimed at converting existing ICE two wheeler into electric two wheelers.

During his internship/training he has demonstrated his skills with self-motivation to learn new skills. His performance exceeded our expectations and he was able to complete the project on time.

We wish him all the best for his/her upcoming career.

E2way Private Limited

Director

Prajwal Kulkarni

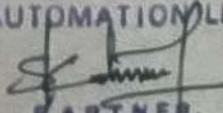
NEX-G
AUTOMATION

NEX-G AUTOMATION LLP

CERTIFICATE OF INTERNSHIP

This is to certify that **Mr. KISHAN UDAY BIJJUR**, student of 8th Semester, department of Automation and Robotics, **KLE Technological University Hubballi**, bearing Reg No **01FE17BAR020**, has successfully completed Internship project on **"WAREHOUSE MANAGEMENT USING RFID TAGS"**, from 10th January 2022 - 31st may 2022, as part of the internship training, he has been placed in the Design and Development team and involved in relative activity of the project. During the internship with us he was found punctual, hardworking and inquisitive.

For NEX-G AUTOMATION LLP.


PARTNER.
Authorized Signature

www.nexgautomation.com

31-05-2022

NEX-G
AUTOMATION

NEX-G AUTOMATION LLP

CERTIFICATE OF INTERNSHIP

This is to certify that **Mr NAGRAJ ANGADI**, student of 8th Semester, department of Automation and Robotics, **KLE Technological University Hubballi**, bearing Reg No **01FE17BAR031**, has successfully completed Internship project on **"WAREHOUSE MANAGEMENT USING RFID TAGS"**, from 10th January 2022 - 31st may 2022, as part of the internship training, he has been placed in the Design and Development team and involved in relative activity of the project. During the internship with us he was found punctual, hardworking and inquisitive.

For NEX-G AUTOMATION LLP.

Kannu
PARTNER.

Authorised Signature

www.nexgautomation.com

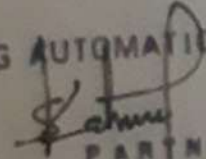
31-05-2022

NEX-G
AUTOMATION

NEX-G AUTOMATION LLP

CERTIFICATE OF INTERNSHIP

This is to certify that **Mr. NAKUL SINGH HAJERI**, student of 8th Semester, department of Automation and Robotics, **KLE Technological University Hubballi**, bearing Reg No **01FE17BAR033**, has successfully completed Internship project on "**WAREHOUSE MANAGEMENT USING RFID TAGS**", from 10th January 2022 - 31st may 2022, as part of the internship training, he has been placed in the Design and Development team and involved in relative activity of the project. During the internship with us he was found punctual, hardworking and inquisitive.

For NEX-G AUTOMATION LLP

PARTNER.
Authorised Signature

www.nexgautomation.com



N-26, Industrial Estate, Gokul Road, HUBLI - 580 030. (India)
Tel. : ++91-836- 2333759, 2330299 Fax : ++91-836- 2330442
E- mail : kcspl@karnatakaconveyors.com • accounts@karnatakaconveyors.com
Web : <http://karnatakaconveyors.com>

CERTIFICATE

This is to certify that Mr. Rohit Chougale (01FE17BAR049) student of KLE Technological University, Vidyanagar- 580 032 was permitted to carry out his Internship in our Company during the period from 10-01-2022 to 31-05-2022 as part of his curriculum. He has shown keen interest in learning and has completed his internship for the said period.

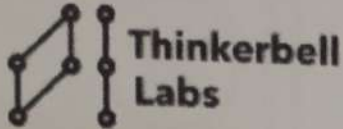
We hope this training course has enabled him to correlate his Class Room Learning with Field exposure.

We wish him all the best in his future career.

For KARNATAKA CONVEYORS & SYSTEMS PVT LTD.,

(M.G. NAIK)
Manager Finance & Admn.

Place : Hubli.
Date : 31.05.2022



Thinkerbell Labs Private Limited

CIN: U72900KA2016PTC094046

262, 6th Main Road, Stage 2, BTM Layout, Bengaluru - 560076

+91 9538904328 | contactus@thinkerbelllabs.com

TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Ankit Shirurmat** has been a part of Thinkerbell Labs Pvt. Ltd. as a **Supply Chain and Manufacturing** from 17th Jan -2022 to 31st May 31 -2022. During this time, he worked on **Quality Assurance, Testing and Procurement** for manufacturing of our product Annie. He successfully completed the project allotted to him along with complete documentation.

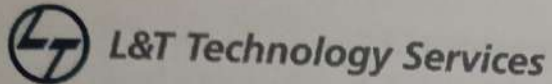
During his internship, Ankit Shirurmat displayed great enthusiasm, skill, willingness to learn and his conduct has been exemplary.

Yours sincerely,

A handwritten signature in black ink, appearing to read "Saif Shaikh", is written over a faint circular stamp or watermark.

Saif Shaikh
Director, CPO
Thinkerbell Labs Pvt. Ltd.

INTERNSHIP COMPLETION CERTIFICATE



L&T-TS HR/99007640

18 May 2022

Mr.Omkar Chitragar

INTERNSHIP CERTIFICATE

This has reference to your Completion of Internship under Genesis Programme in L&T Technology Services Limited (LTTS).

Relevant details of internship during the tenure with LTTS are as under.

INTERNSHIP ID	: 99007640
INTERNSHIP START DATE	: 1 February 2022
INTERNSHIP END DATE	: 13 May 2022
LOCATION	: Mysore

We wish you success in your future endeavours.

Yours Sincerely,
For L&T Technology Services Limited,

A handwritten signature in black ink, appearing to read 'Ashwin J'.

Ashwin J
Senior Manager – HR Employee Relations & Compliance

8th June 2022

To Whomsoever it May Concern

This is to certify that **Mr.Prathik A** pursuing his Bachelor of Automation and Robotics Engineering, 8th semester at KLE Technological University, Hubli, India has completed the internship on Machine Learning from 10th January 2022 to 31st May 2022 at Bamboo Rose (India) Pvt.Ltd., Bangalore.

We found him sincere, hardworking, and technically sound and result oriented. He worked well as part of a team during his tenure.

We wish him success for all his future endeavors.

Sincerely,

Manja Naika L,
MD, India Operations,
Bamboo Rose (India) Pvt Ltd.



15th June 2022

CERTIFICATE

This is to certify that Mr. Titas Dewan- student of Automation And Robotics, KLE Technological University has successfully completed five month long internship at Technicious Technology Services Pvt Ltd. During his internship he was part of the Team which was responsible for developing HMS system.

✓ Project: Healthcare Information Management System Technologies

Used: Django(Python Framework, React Js)

The candidate was found to be enthusiastic, hardworking and a quick learner during his short stint at Technicious Technology Services. His performance has been assessed as excellent.

We wish him every success in his life and career.

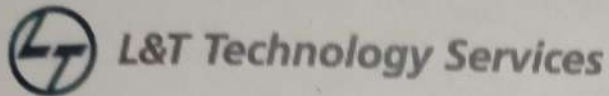
For Technicious Technology Services private Ltd.

Sabareesan Sankaran,
Director

Technicious Technology Services

R.S No 182/5 A-7, Evergreen homes, Nagala Park, Kolhapur, Maharashtra - 416003

CERTIFICATE OF INTERNSHIP



L&T-TS HR/99007611

18 May 2022

Ms. Vandana Devetkal

INTERNSHIP CERTIFICATE

This has reference to your Completion of Internship under Genesis Programme in L&T Technology Services Limited (LTTS).

Relevant details of internship during the tenure with LTTS are as under.

INTERNSHIP ID : **99007611**
INTERNSHIP START DATE : **1 February 2022**
INTERNSHIP END DATE : **13 May 2022**
LOCATION : **Mysore**

We wish you success in your future endeavours.

Yours Sincerely,
For L&T Technology Services Limited,

A handwritten signature in black ink, appearing to read 'Ashwin J'.

Ashwin J
Senior Manager – HR Employee Relations & Compliance

Creintors Automation Solutions Pvt.Ltd.

An Integrated Management System Certified Company
(Aligned with ISO 9001, 14001, 27001 and 45001)

Ref No: CASPL/IL/08/06/2022



TO WHOMSOEVER IT MAY CONCERN

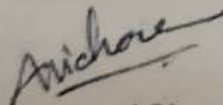
This is to certify that Mr. Vishal Hatti, USN : 01FE18BAR045, Studying in IVth Year BE In Automation & Robotics from KLE Technological University, Hubli-580031. He has Successfully completed his Internship Training under the guidance of Mrs. Disha Chougule, Assistant Manager Software, on "Programming, Control & Communication in Industrial Automation Systems" and also completed the project on Automation of Vertical Storage System, at Creintors Automation Solutions Pvt Ltd, Waghawade Road, Waghawade- Belgaum-590018 from 17th January 2022 to 03rd June 2022.

During the period of his internship with us, we found him sincere, hardworking and a quick learner.

We wish him all the best in his future endeavor.

With Regards

For Creintors Automation Solutions Pvt. Ltd.


Authorised Signatory



Plot No-2, Survey No. 22/3, Waghawade Road, Waghawade, Belgaum 590018 Karnataka, India.
Mob: +91 77950 00801 | E-mail: sales@cautomate.com | Website: www.cautomate.com
CIN No. U29266KA2017PTC101599



Farmercoin Smart Robotic Solutions
(OPC) Pvt Ltd.
Start-up street, 1st Floor,
R H Kulkarni Building
KLE technological University.
Vidyanagar, Hubli.
580031

CERTIFICATE

This is to certify that **Mr Vishnudath AP USN: 01FE18BAR046** student of **Bachelor of Engineering, KLE Technological University, Hubballi** has successfully completed his Internship training on **Product design development and PCB design** in our organization from **10th Jan 2022 to 31st May 2022**.

He took keen interest in the work assigned to him. His conduct and behaviour was found good.

We wish him all success in his future endeavours.

Date: 31st May 2022

Name: Mr. Ishwar

Signature:

(Mentor)

Name: Dr. Arun shetter

Signature:

(Head of Organization)



CERTIFICATE OF TRAINING & INTERNSHIP

We hereby proudly present this certificate of internship for outstanding, honourable effort of **Mr. Vivek M** bearing **USN 01FE18BAR047**, bonafide student of **Automation and Robotics** department, KLE Technological university for his/her successful completion of internship program conducted from **Jan 10th 2022 to May 31st 2022**.

The Outcome Of Internship Achieved:

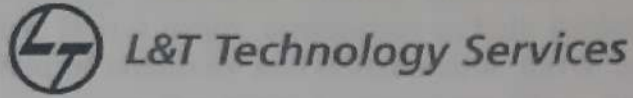
- Technology trained on HTML, CSS, Javascript and React JS
- Understand to implement Software development cycle using Agile Model
- Requirement gathering & Analysing
- Building various use case
- Coding, Debugging & Testing
- Hosting & Deploying the Software
- Team Meeting, Overcoming challenges & providing Quick Solutions.

During the course of "Internship" he/she has shown keen interest in learning & a very sincere worker.

We wish all the best for future Endeavours.



Authorized Signatory



L&T-TS HR/99007472

18 May 2022

Ms. Chaitali Rokhade

INTERNSHIP CERTIFICATE

This has reference to your Completion of Internship under Genesis Programme in L&T Technology Services Limited (LTTS).

Relevant details of internship during the tenure with LTTS are as under.

INTERNSHIP ID	: 99007472
INTERNSHIP START DATE	: 1 February 2022
INTERNSHIP END DATE	: 13 May 2022
LOCATION	: Mysore

We wish you success in your future endeavours.

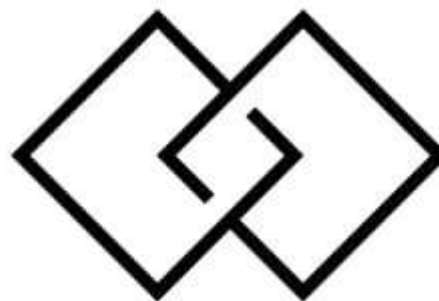
Yours Sincerely,
For L&T Technology Services Limited,

A handwritten signature in black ink, appearing to read 'Ashwin J'.

Ashwin J
Senior Manager – HR Employee Relations & Compliance



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KLE Tech.
CASE
Center for Automation Systems Engineering

CERTIFICATE OF INTERNSHIP

This certifies that

Aniket A. Jain

has completed a Training and Project work in

Autonomous Mobile Robot with Manipulator - VRL Logistics Ltd.

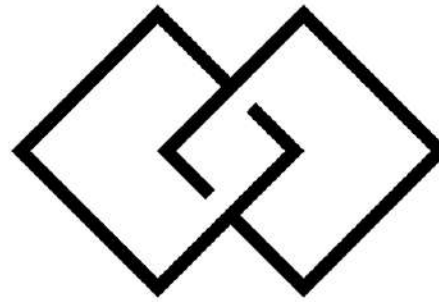
at KLE Tech's Center for Automation Systems Engineering (CASE), for the period of 6 Months
starting from January 2022.

ARUN C. GIRIYAPUR
Administrator

KARTIK LAKAMANHALLI
Manager, Systems Engineering



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CASE
Center for Automation Systems Engineering

CERTIFICATE OF INTERNSHIP

This certifies that

Amrut S. Kurtkoti

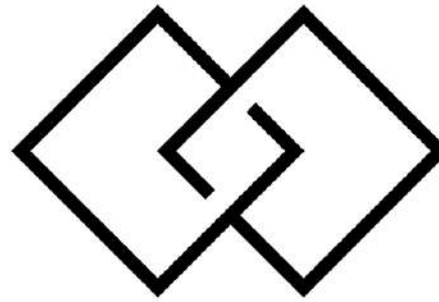
has completed a Training and Project work in **Welding Robot - VRL Logistics Ltd.**
at KLE Tech's Center for Automation Systems Engineering (CASE),
for the period of 6 Months starting from January 2022.

ARUN C. GIRIYAPUR
Administrator

KARTIK LAKAMANHALLI
Manager, Systems Engineering



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CERTIFICATE OF INTERNSHIP

This certifies that

Faizan Pathan

has completed a Training and Project work in

Autonomous Mobile Robot with Manipulator - VRL Logistics Ltd.

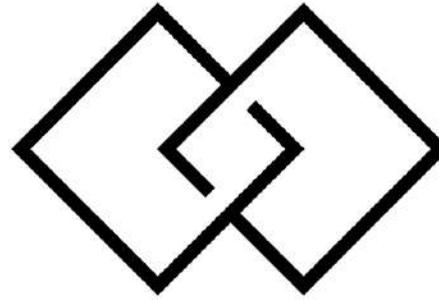
at KLE Tech's Center for Automation Systems Engineering (CASE), for the period of 6 Months
starting from January 2022.

ARUN C. GIRIYAPUR
Administrator

KARTIK LAKAMANHALLI
Manager, Systems Engineering



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CERTIFICATE OF INTERNSHIP

This certifies that

Prasad K. Basaragi

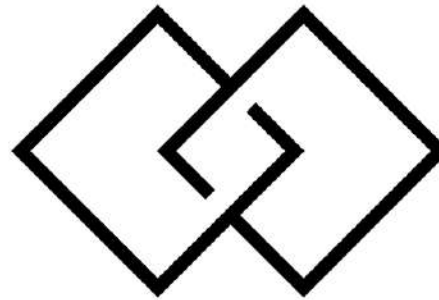
has completed a Training and Project work in **Welding Robot - VRL Logistics Ltd.**
at KLE Tech's Center for Automation Systems Engineering (CASE),
for the period of 6 Months starting from January 2022.

ARUN C. GIRIYAPUR
Administrator

KARTIK LAKAMANHALLI
Manager, Systems Engineering



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CERTIFICATE OF INTERNSHIP

This certifies that

Rani R. Kinnal

has completed a Training and Project work in

Autonomous Mobile Robot with Manipulator - VRL Logistics Ltd.

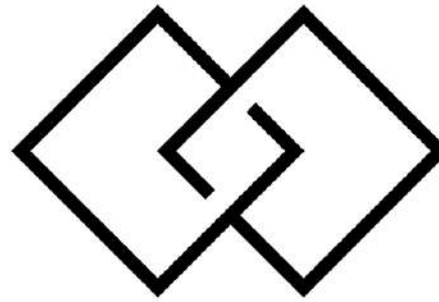
at KLE Tech's Center for Automation Systems Engineering (CASE), for the period of 6 Months
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Manager, Systems Engineering



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CERTIFICATE OF INTERNSHIP

This certifies that

Ritika S. Javalagi

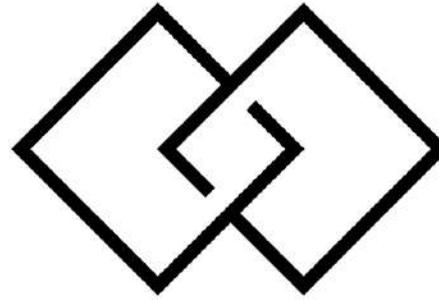
has completed a Training and Project work in **Welding Robot - VRL Logistics Ltd.**
at KLE Tech's Center for Automation Systems Engineering (CASE),
for the period of 6 Months starting from January 2022.

ARUN C. GIRIYAPUR
Administrator

KARTIK LAKAMANHALLI
Manager, Systems Engineering



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CERTIFICATE OF INTERNSHIP

This certifies that

Spoorti Hiremath

has completed a Training and Project work in

Tyre Wear Measurement System - VRL Logistics Ltd.

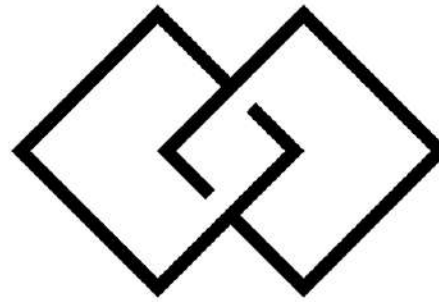
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Administrator

KARTIK LAKAMANHALLI
Manager, Systems Engineering



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CERTIFICATE OF INTERNSHIP

This certifies that

Vishal Shibargatti

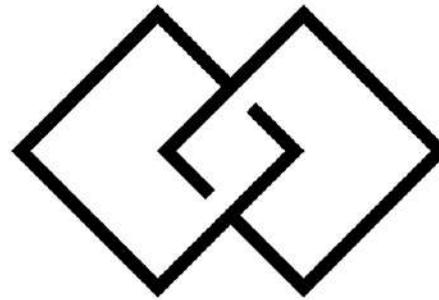
has completed a Training and Project work in **Welding Robot - VRL Logistics Ltd.**
at KLE Tech's Center for Automation Systems Engineering (CASE),
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Administrator

KARTIK LAKAMANHALLI
Manager, Systems Engineering



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CERTIFICATE OF INTERNSHIP

This certifies that

Darshan P. Nagda

has completed a Training and Project work in

Tyre Wear Measurement System - VRL Logistics Ltd.

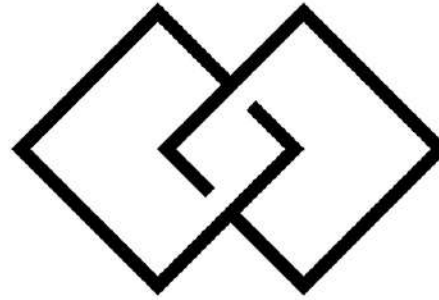
at KLE Tech's Center for Automation Systems Engineering (CASE), for the period of 6 Months
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Administrator

KARTIK LAKAMANHALLI
Manager, Systems Engineering



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CERTIFICATE OF INTERNSHIP

This certifies that

Shraddha S. Vaidya

has completed a Training and Project work in

Tyre Wear Measurement System - VRL Logistics Ltd.

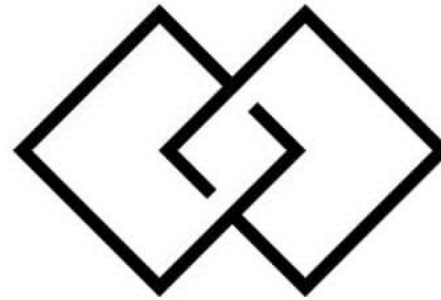
at KLE Tech's Center for Automation Systems Engineering (CASE), for the period of 6 Months
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Administrator

KARTIK LAKAMANHALLI
Manager, Systems Engineering



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CERTIFICATE OF INTERNSHIP

This certifies that

Kiran M. Guled

has completed a Training and Project work in **Welding Robot - VRL Logistics Ltd.**
at KLE Tech's Center for Automation Systems Engineering (CASE),
for the period of 6 Months starting from January 2022.

ARUN C. GIRIYAPUR
Administrator

KARTIK LAKAMANHALLI
Manager, Systems Engineering