SCHEME OF STUDIES

DIPLOMA
IN
ELECTRONICS
&
COMMUNICATION ENGINEERING
(C-20)

V SEMESTER

CURRICULUM STRUCTURE

V Semester Scheme of Studies - Diploma in Electronics & Communication Engineering [C-20]

Pathway	Course Category / Teaching Department	Course Code	Pathway Title	Hours per Semester			Total contact hrs /Semester	Credits	CIE Marks		SEE-1 Marks (Theory)		SEE-2 Mark (Practical)		Total Marks	Min Marks for Passing (including CIE marks)	Assigned Grade	Grade Point	SGPA and CGPA
				L	T	P			Max	Min	Max	Min	Max	Min					
Programme Specialization Pathway																			Both SGPA & CGPA
1	**EC** Specialization pathways in emerging areas Student may select any one of the specializations	**20EC51I**	**1. Drone Technologies**	104	52	312	468	24	240	96	60	24	100	40	400	160			
		20EC52I	**2. Industrial Internet of Things (IIoT)**	104	52	312	468	24	240	96	60	24	100	40	400	160			
		20EC53I	**3. Automation & Robotics**	104	52	312	468	24	240	96	60	24	100	40	400	160			
		20EC54I	**4. E - Mobility**	104	52	312	468	24	240	96	60	24	100	40	400	160			
Science and Research Pathway				L	T	P	Total	Credits	**CIE Marks**		**SEE Marks**								
									Max	**Min**	**Max**	**Min**							
2	BS/SC/EC Specialization pathway in Science and Research **(Student need to take all four papers in this pathway)**	2OSC51T	Paper 1-Applied Mathematics	52	26	0	78	6	50	20	50	20			100	40			
		2OSC52T	Paper 2 – Applied Science	52	0	52	104	6	50	20	50	20			100	40			
		2ORM53T	Paper 3 – Research Methodology	52	0	52	104	6	50	20	50	20			100	40			
		2OTW54P	Paper 4 – Technical Writing	39	13	52	104	6	60	24	40	16			100	40			
			Total	195	39	156	390	24	210	84	190	76			400	160			
Entrepreneurship Pathway																			
3	ES/EC	20ET51I	Entrepreneurship and Start up	104	52	312	468	24	240	96	160	64			400	160			

L:- Lecture T:- Tutorial P:- Practical BS- Basic Science:: ES-Engineering Science:: SC: Science

Note: In 5th Semester student need to select any one of the pathways consisting of 24 credits

Students can continue their higher education irrespective of the Pathway selected

CURRICULUM STRUCTURE

VI Semester Scheme of Studies - Diploma in Electronics & Communication Engineering [C-20]

Pathway	Course Category / Teaching Department	Course Code	Pathway	Course		Total contact	Credits	CIE Marks		SEE Marks		Total Marks	Min Marks for Passing	Assigned Grade	Grade	SGPA and CGPA
								Max	Min	Max	Min					
Internship	ES/EC	20EC61S	Specialisation pathway	Internship/ project	40 Hours / week Total 16 Weeks	640	16	240	96	160	64	400	160			
		20EC61R	Science and Research Pathway	Research project	40 Hours / week Total 16 Weeks	640	16	240	96	160	64	400	160			
		20EC61E	Entrepreneurship and Start up pathway	Minimum Viable Product - MVP/ Incubation/ Startup proposal	40 Hours / week Total 16 Weeks	640	16	240	96	160	64	400	160			

Note: Student shall undergo Internship/Project/research project/MVP/Incubation/Startup proposal in the same area as opted in 5th semester pathway.

Drone Technologies

Government of Karnataka

DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Program	**Electronics & Communication Engineering**	**Semester**	**5**
Course Code	**20EC51I**	**Type of Course L:T:P**	**104: 52: 312**
Specialization	**Drone Technologies**	**Credits**	**24**
CIE Marks	**240**	**SEE Marks**	**160**

Introduction:

Unmanned Aerial Vehicles aka Drones have become one of the fastest trending and growing technologies in the history of mankind. The nature of these vehicles being easy to deploy, expendable and customizability features and relatively affordable when compared to manned aircrafts makes it the preferred option for various industries. The acceptance of drones to traditional industries such as surveillance, agriculture, delivery, surveying and many more has revolutionized entire industries by providing much accurate performance and greater results.

Drone being a true sunrise industry is currently in its infancy and requires a lot of research, development and testing before it is widely accepted and deployed. Drones being a multidisciplinary domain requires skilled talent from every engineering domain. With more than 60% of the applications of drones yet to be found and implemented, there lies a huge potential untapped in this industry. According to a few reports, the drone industry in India is expected to reach a whopping 68 billion dollars by 2027. This opens up a lot of opportunities to the youth who can get trained and can excel in this field of technology.

Pre-requisite

Before the start of this specialization course, you will have prerequisite knowledge gained in the first two years on the following subjects:

1st year -Engineering Mathematics, Communication Skills, Computer Aided Engineering Graphics, Statistics & Analysis, Basic IT Skills, Fundamentals of Electrical and Electronics Engineering, Project Management skills, Digital Electronics

2nd year- Analog Electronics, Logic Design using Verilog, Communication Systems, Electronic Measurements and Testing Techniques, PCB Design & Fabrication, Wireless Communication, Embedded C Programming, Industrial Automation, in this year of study, you shall be applying your previous years learning along with specialized field of study into projects and real-world applications.

Instruction to course coordinator.

1. Each Specialized field of study is restricted to a Cohort of 20 students which could include students from other relevant programs.
2. One faculty from the Core Discipline shall be the Cohort Owner, who for teaching and learning in allied disciplines can work with faculty from other disciplines or industry experts.
3. The course shall be delivered in boot camp mode spanning over 12 weeks of study, weekly developmental assessments and culminating in a mini capstone.

4. The industry session shall be addressed by industry experts (in contact mode/online / recorded video mode) in the discipline only.
5. The cohort owner shall be responsible to identify experts from the relevant field and organize industry session as per schedule.
6. Cohort owner shall plan and accompany the cohort for industrial/mines/site/showroom/service Centre visits.
7. Cohort owner shall maintain and document the industrial assignments, weekly assessments, practices and mini project.
8. The cohort owner shall coordinate with faculties across programs needed for their course to ensure seamless delivery as per time table
9. The cohort owner along with classroom can augment or use for supplementally teaching on line courses available although reliable and good quality online platforms like Karnataka LMS, Infosys Springboard, NPTEL, Unacademy, SWAYAM etc.
10. Report should be maintained for industrial/field visit, such report shall be considered as industrial assignment.

Course outcomes: On successful completion of the course, the students will be able to,

CO1	**Explain the Concept of UAV, its components and its known applications.**
CO2	**Identify the type of drone and design a drone for a given application/specification.**
CO3	**Build, Comply, Configure and Test the drone for a given design specification.**
CO4	**Plan & Estimate the different Payload Configurations, redesign (if required) and Integrate with the given drone.**
CO5	**Apply the Regulations/Laws to legally fly a drone, Identify the problem if any and troubleshoot to obtain the desired result/outcome.**

Detailed course plan

Week	C O	P O	Days	1st session (9 am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
1	**Learning Outcomes**			❖ **Learn the different types of unmanned vehicles.** ❖ **Understand the basic fundamentals of flight**							
	1,2	1,5	1	• Introduction, • History, • UV types -UGV,UAV,USV,UUWV • Drones in india • Applications • Future scope	2		2	UAV Types, • Based on configuration, • Based on weight, • Based on altitude, • Based on kit types	2		1
	1,2	1,3,7	2	• Principles, • Newton's laws, • Degrees of freedom • Stick movements	2		2	**Design Brief-1** (Make a Paper Plane) *Description* • Aerodynamics • Flight force-Thrust, weight, drag, lift.	1	1	1
	1,3	1,3,4	3	• Flight modes • Basic maneuvers • Take-off, pitch, roll, yaw, land	1	1	2	**Practicals** • Simulator kit – To Do software simulation on take off and landing • Transmitter setup • Model configuration • Calibration	1		2
	2,4,5	2,3,5	4	**Design Lab** (Design software Introduction/Familiarisation-1) + **Rules** (Introduction to regulations)	1	1	2	**Problem Statement** **(Design Thinking)**		1	2
			5	**Developmental Assessment**				Assessment Review and corrective action			3

	5	7	6	**Industry class** (Aeronuts) Aerodynamics of Airplanes - wingspan, drag, drag coefficient, long range gliders, etc + **Flying session** (Take-off & Landing)	1		3	Weekly Assignment(1PM-2PM)			1
2	**Learning Outcomes**			❖ **Learn the basics to control and fly a drone** ❖ **Use nano drone and explain its features** ❖ **Understand the micro controllers and processors**							
	1,3	4	1	Assignment review + **Simulator Session - pitch and roll**		3	1	• Introduction to nano drone ➢ Features ➢ Components	1		2
	2,3	3,4	2	• Nano drone setup • Configuration • Binding Tx and Rx in nano drone	1		3	**Design Brief-2** (scenario of -Crowd Safety/Event security etc.) *Description* • Flight planning • Pre-flight checks • Drone flight	1	1	1
	1	4	3	Micro controllers VS Micro Processors Uses, pros & cons	1	1	2	**Practicals** • Intro to Arduino • Sensors • Program structure • Basic logics on using the above for any given case study	1		2
	2,5	2,5	4	**Design Lab** (Design software introduction/Familiarisation - 2) + **Rules** (Regulating Departments)	2		2	**Problem Statement** Customer issues on • pain points • surveys on it.		1	2

			5	**Developmental Assessment**				Assessment Review and corrective action			3
	5	7	6	**Industry class** (Drona Aviation) Pluto, sensors, gyros, number of iterations of drone, micro processors and micro controllers + **Flying Session** (Pitch & Roll)	1		3	Weekly Assignment			1
3	**Learning outcomes**			❖ **Understand the basic of an Arduino** ❖ **Learn to integrate sensors onto the nano drone**							
	1,2	1	1	Assignment review + **Simulator Session- track flight**		3	1	• Pluto IDE(Integrated development environment) - software for drone • Port nos- its use in connecting different computers • Baud rate	1		2
	2,3	1,4	2	**Design Brief-3** *Description*- Mission based Analog sensor integration • Sensor Selection • Sensor Integration	1		3	• Sensor Configuration • Testing • Debugging	1		2
	3	4	3	**Practicals** Test Flight with nano drone			4	**Practicals** Test flight with nano drone			3
	2,5	2,5	4	**Design Lab** (Nano Frame) + **Pilot Licensing** (Training and licensing)	2		2	**Problem Statement** Business Plans-Potential Solutions, Market research	1		2
			5	**CIE 1 – Written and Practice Test**				Assessment Review and corrective action			3
	5	7	6	**Industry class** (Go RC) Goradio control, Planes, investors, market research , etc **+**	1		3	Weekly Assignment(1PM-2PM)			1

				Flying session (Track flight)								
4	**Learning Outcomes**			❖ **Understand the working off all components of an electric propulsion system of a drone**								
	2,3	3,4	1	Assignment review **+** **Simulator Session -obstacle landing**		3	1	• Propulsion systems ➢ Types, ➢ Wiring schematic	1		2
	1,2,3	4	2	• Motor ➢ Size, Power rating ➢ Material used	1	1	2	• Propellers ➢ size, types, materials	1		2
	2,3,4	1,4	3	• ESC(Eectronic Speed Controller) ➢ Rating, ➢ Protocol, ➢ setup	1		3	• Battery ➢ Power output,leads ➢ Charger ➢ Modes, setup, safety ➢ PDB(Power Distribution Board) ➢ Voltage regulation, Power rating	1	1	1
	3,5	2,4	4	**Design Lab** (Propellers) + **Drone Requirements** (Planning,Guide,NPNT[no permission no takeoff], Check List)	2		2	**Problem Statemen** (Requirement gathering of customer/Research)	1		2
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	5	7	6	**Industry class** (Fly Camp) batteries , Lipo,nicd,Li-ion,etc, business **+** **Flying session** (Obstacle Landing) Operate nano drone through mobile phone	2		2	Weekly Assignment (1PM – 2PM)			1
5	**Learning Outcomes**			❖ **Understand the math and relation between the components of the propulsion system using a thrust stand**								
	1,2	1,4	1	Assignment review + **Simulator Session – regular flight**		3	1	• Introduction to thrust stand • Its Basic features	1		2

	1,3	4,6	2	• Thrust stand setup • Load cell- sensor indicates the weight , which is used to know the thrust requirement for flight • RPM Probe • Base	1		3	**Practicals** • Thrust stand experiments- (with this motor , the thrust required for any type of drone is calculated. ex.Quadcopter,Hexacopter) • Thrust calculations	1		2
	2,3	3,4,6	3	**Practicals** • Thrust stand experiments ➢ Efficiency calculation[output power/Input power]- To obtain flight time calculation , etc.	1	1	2	**Design Brief-4** (System Design/Power house) *Description*-Propulsion (ex.Hexacopter Calculations for 2kg of thrust can carry how much of the payload)	1		2
	3,5	2,7	4	**Design Lab** (motor mount) + **Rules** (Drone Certification)	2		2	**Problem Statement** (Ideation) Brain storming /ideas for a start up	1		2
			5	**CIE 2 – Written and Practice Test**				Assessment Review and corrective action			3
	5	7	6	**Industry class** (Asteria) Talk about flycamp as startup, their mistakes, their success stories,etc + **Flying session** (physical Transmitter module for control) nano drone	2		2	Weekly Assignment (1 PM-2PM)			1
6	**Learning Outcomes**			❖ **Understand the working & details of all other electronic components in an industry grade drone**							
	1	1	1	<u>Assignment review</u> ± **Simulator Session-** Take-off & Landing		3	1	• Frame ➢ Size, Configuration ➢ Material	2		1
	1,4	1,4	2	• FC(flight controller) • Gyroscope, accelerometer, GPS,	2		2	• RX ➢ Protocol, channels,	1		2

				• GCS(Ground control station) • mission planner- software and its uses • Ardu pilot(firmware/autopilot system)-flight controller software				• TX ➢ Binding, setup • FPV(First person view) ➢ Camera, VTX(video TX),antenna • Telemetry • Frequency, pairing, power			
	4,5	2,3	3	**Design Brief-5** (Search and Rescue) *Description*- Payload Selection	1	1	2	• Payloads • 3D arms • Magnetometer • Dropping mechanisms OR sense & avoid	1		2
	,35	2,3	4	**Design Lab** (Arm holder)-arms connected to the body ex. Folding arm, fixed arm + **Rules** (Radio Telephony)	2		2	**Problem Statement** (System architecture) Ex. Drone ecosystem for dropping mechanism. (Pilot study – Natural disaster : mobile app-cloud computing-drone-medicine dropped to destination etc)	1		2
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	5	7	6	**Industry class** (Z-motion) **+** **Flying session** (Take-off & Landing)	2		2	Weekly Assignment (1PM-2PM)			1
7	**Learning Outcomes.**			❖ **Learn to setup, test and fix all critical components**							
	2,3	3,4	1	Assignment review + **Simulator Session- first person view**		3	1	• Vehicle Setup and configuration ➢ Ex. vehicle set up has to be done ○ Before connecting drone to mission planner • Type of drones for vehicle setup	1		2
	3	4	2	• Tools- To assemble the drone • Assembly procedure	1		3	**Practicals** • Transmission system • Setup, • Propulsion testing (for flight controller)	1		2

	3,5	4	3	**Practicals** • Configuration of Transmission system	1	1	2	• Fault finding • Troubleshooting	1		2
	4,5	2,4	4	**Design Lab** (Antenna holders) controller, telemetry, video antennas + **Rules** (Weather & Meteorology)	2		2	**Problem Statement** (Concept and Feasibility of ideation done previously) Market survey, demand etc	1		2
			5	**CIE 3 – Written and Practice Test**				Assessment Review and corrective action			3
	5	7	6	**Industry class** (RedwingLabs) debugging, fault tolerance **+** **Flying session** (FPV)	2		2	Weekly Assignment (1PM – 2PM)			1
8	**Learning Outcomes.**			❖ **Understand how to setup a drone on the ground control softwares and prepare for flight**							
	2	5	1	Assignment review + **Simulator Session -** Pitch & Roll		3	1	**Design Brief-6** (Safety & privacy) **(For using Drone used for a purpose safely)** VVIP Police security	1		2
	4,5	4	2	• Failsafe types ➢ setup ➢ Ground test	1		3	**Practicals** • Test flight • basic hovering • Maneuvers			3
	3,5	3,4	3	**Practicals** PID Tuning – Rate setup (Process to make the drone fly with vibrations)	1		3	**Practicals** • GPS features • GSC Setup • Way point navigation • Return to home	1		2

	4,5	2,6	4	**Design Lab** (Landing gear) + **Rules** (Airspace structure)	2		2	**Problem Statement** (Prototyping- before final drone do prototype in different materials, processes etc. with feedback)	1		2
			5	Developmental Assessment				Assessment Review and corrective action			3
	5	7	6	**Industry class** (Poeir Jets) designing aspects. etc + **Flying session** (Pitch & Roll)	2		2	Weekly Assignment (1PM-2PM)			1
9	**Learning Outcomes.**			❖ **Learn to select and integrate different payloads on drones and test flight it**							
	4,5	3	1	Assignment review + **Simulator Session- Hover Yaw**		3	1	Payload Selection	1		2
	1,3	1,4	2	Introduction to Companion computers (customization)	1		3	Use Arduino/raspberry pi (ex. obstacle sensor is connected to Arduino & in turn connected to flight controller)	1		2
	2,4	1,4	3	**Practicals** Sensor integration	1	1	2	• Payload Testing • Payload configuration	1		2
	52		4	**Design Lab** (Payload 1) + **Rules** (Emergency Procedures)	2		2	**Problem Statement** (Test, feedback)	1		2
			5	**CIE 4 – Written and Practice Test**				Assessment Review and corrective action			3
	5	7	6	**Industry class** (Skylark) PIDs, expos rates filtering, etc	2		2	Weekly Assignment(1PM-2PM)			1

				+ **Flying session** (Hover Yaw)							
10	**Learning Outcomes**			❖ **Can maintain and conduct test flights**							
	4	4	1	Assignment review + **Simulator Session - applying Brake**		3	1	• Basic tuning • Test Flight	1		2
	3	3	2	**Practicals** Test Flight			4	**Practicals** • Overhaul • Flight	1		2
	5	2,5	3	Troubleshoot /Test	1	1	2	• Flight / feedback • Disassembly • Feedback on the entire	1		2
	4,5	2,5	4	**Design Lab** (Payload 2) + **Ethics** (Danger of UAVs)	2		2	**Problem Statement** (Cost of using various payloads)			3
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	5	7	6	**Industry class** (Tsalla) projects involving 3D mapping, obstacle avoidance and such that involve on board computation on the edge + **Flying session** (Breaking system)	2		2	Weekly Assignment (1PM-2PM)			1
	Learning Outcomes			❖ **Implement additional skills required for manufacturing and overhaul**							
11	2,3	3	1	Assignment review + **Simulator Session – Bank turns**		3	1	• Design for Manufacturing • Prototyping Methods -Explain all rapid prototyping methods . ex. 3D	1		2

								printing, Laser cutting, CNC Cutting etc.			
	2	5	2	• Flight log analysis • Black box extraction	1		3	**Practicals** Flight simulation	1		2
	5	5	3	**Design Lab** (Frame 1) + **Ethics** (Safety and Privacy)	1	1	2	Future scope	1		2
	5	6,7	4	**CC-1** Industry Contact class for troubleshooting	1		3	**Problem Statement** (Process creation) All operational processes that need to be created like :Purchase, Hiring, accounting, customer management ,etc.	1		2
			5	**CIE 5 – Written and Practice Test**				Assessment Review and corrective action			3
	5	7	6	**Industry class** (DFI) DFI and future of drones in India **+** **Flying session** (Bank turns)	2		2	Weekly Assignment(1PM-2PM)			1
12	**Learning Outcomes.**			**1. Know Government schemes to encourage Drone industry** **2.Learn about few top drone companies in India**							
	5	3	1	Assignment review + **Simulator Session – Auto mission**		3	1	Government funds	1	1	1
	5	6	2	Indian drone firms	1	1	2	• Government schemes • Student competitions • Drone related events to encourage Drone Industry.	1	1	1

	2,5	2,5	3	**Design Lab** (Frame 2) + **Ethics** (Do's and Don'ts)	1	1	2	**Problem Statement** (Documentation of the project done by each team)	1		2
	5	7	4	**CC-2** Industry Contact class	1		3	**CC-3** Industry Contact class	1		2
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	5	1,5	6	**Industry class** (Aarav) NPNT and swamitva scheme **+** **Flying session** (Auto Mission)	2		2	Weekly Assignment(1PM-2PM)			1
13											
			1	**Internship** **a) Secondary research on various industries and their operations to identify at least 3 companies along with the areas of work interest and develop an internship plan that clearly highlights expectations from the industry during the internship.** **b) Design and develop a cover letter for an internship request to all 3 identified companies and the resume to be submitted to potential companies.** **c) Prepare for an internship interview to highlight your interests, areas of study, career aspirations and personnel competence – including the areas of learning you expect to learn during internships Review**				**Project** **a) Identification of the problem statement (from at least 3 known problems) the students would like to work as part of the project – either as provided by faculty or as identified by the student. Document the impact the project will have from a technical, social and business perspective.** **b) Design and develop the project solution or methodology to be used to solve at least one of the problems identified.** **c) Prepare a project plan that will include a schedule, WBS, Budget and known risks along with strategies to mitigate them to ensure the project achieves the desired outcome**			40
			2								
			3								
			4								
			5								
			6								

NOTE:

1. **Kit usage/week:**
   - **Simulator kit : all weeks**
   - **Nano kit : week 2,3**
   - **Thrust stand kit : week 4,5**
   - **Industrial drone kit : 6,7,8,9,10,11**

2. **Open-source Design Software can be used for DESIGN LAB Every week – freeCAD/ Onshape/CAD Builder etc.**

3. **Cohort owner can further divide the cohort of 20 into sub Teams(4-5 teams) and assign them different project designs ,that will be carried forward every week under DESIGN BRIEF,PROBLEM STATEMENT and other relevant sessions .**
   for example:
   - **Delivery**
   - **Crop spraying**
   - **Aerial cinematography**
   - **Survey and mapping**
   - **Surveillance**

REFERENCES.

Sl. No	Description
1	Theory, design, and applications of unmanned aerial vehicles – A.R.Jha , CRC Press.
2	Aviation Law and Drones: Unmanned Aircraft and the future of Aviation. – David Hodgkinson and Rebecca Johnston – Routledge Publications.
3	Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation – Daniel Tal , Jon Altschuld, Wiley Publications.
4	Drones (The Ultimate Guide) – Ben Rupert, CreateSpace Independent Publishing house.
5	Basics of Unmanned Aerial Vehicles - Garvit Pandya , Notion Press.

6	Aerodynamics for Engineering Students- Houghton, Elsevier Publications.
7	Quadcopters and Drones: A Beginner's Guide to Successfully Flying and Choosing the Right Drone - Mark Smith , CreateSpace Independent Publishing Platform.
8	Guide to Drone Operations - Russ Flahive , Todd Kishpaugh, independently published.
9	UAS/Drone - Unmanned Aircraft Systems – Pilot Logbook: For drone pilot and operator - Charles D Marden, independently published..
10	Make: Drones: Teach an Arduino to Fly - David Mcgriffy , O'Reilly publications.

CIE and SEE Assessment Methodologies

CIE Assessment	Assessment Mode	Duration In hours	Max Marks
Week 3	CIE 1– Written and practice test	4	30
Week 5	CIE 2– Written and practice test	4	30
Week 7	CIE 3– Written and practice test	4	30
Week 9	CIE 4– Written and practice test	4	30
Week 11	CIE 5– Written and practice test	4	30
	On line Course work (Minimum 10 hours online course with certification from (SWAYAM/NPTEL/Infosys Springboard)		40
	Profile building for Internship / Submission of Synopsys for project work		20
Portfolio evaluation (Based on industrial assignments and weekly developmental assessment) *			30
TOTAL CIE MARKS (A)			**240**
SEE 1 - Theory exam (QP from BTE) Conducted for 100 marks 3 hrs duration reduced to 60 marks		**3**	**60**
SEE 2 – Practical		**3**	**100**
TOTAL SEE MARKS (B)			**160**
TOTAL MARKS (A+B)			**400**

***** The industrial assignment shall be based on peer-to-peer assessment for a total of 10 marks (on a scale of 1 to 10) and in the event of a group assignment the marks awarded will be the same for the entire group, the developmental assessment will be for a total of 20 marks and based on MCQ/case study/demonstration and such other assignment methods

Assessment framework for CIE (1 to 5)

Note : Theory to be conducted for 1 hour and practice for 3 hours, total duration of exam – 4 hours

Programme	**Electronics & Communication Engineering**	**Semester**	**V**
Course	**Drone Technologies**	**Max Marks**	**30**
Course Code	**20EC51I**	**Duration**	**4 hours**
Name of the course coordinator			

Note: Answer one full question from each section.

Qn.No	Question	CL L3/L4	CO	PO	Marks
	Section-1 (Theory) – 10 marks				
1.a)	Write an arduino program to make the nano drone take off automatically when it detects a clap and lands when it detects 2 claps	L3	CO3	1,2,3,4	5
b)	Fill in a Design Thinking template for a solution for "Drones for bank security" .	L4	CO2	1,2,3	5
2.a)	Sketch the wiring schematic diagram of a simple hexacopter with automatic folding landing gears	L3	CO2	1,2,3	5
b)	In mode 2, If the roll stick reflects as the pitch output and if the pitch stick reflects as the yaw output, how would you solve this issue?	L4	CO5	1,2,3,4	3
c)	Write down 5 problems faced by farmers and mention at least 3 solutions that can be implemented using drones to solve these issues.	L3	CO1	1,2,3	2
	Section-2 (Practical) - 20 marks				
3)	Write and execute an arduino program to make the nano drone land when the humidity of the environment increase by 30%	L3	1,2,3,4,5	1,2,3,4,5	20
4)	Design a single piece 2" brushed hexacopter frame .	L4	1,2,3	1,2,3,4,5	20

Note : Theory questions shall be aligned to practical questions

Assessment framework for SEE 1 (Theory)

Programme	**:**	**Electronics & Communication Engineering**			
Semester	**:**	**V**			
Course	**:**	**Drone Technologies**	**Max Marks**	**:**	**100**
Course Code	**:**	**20EC51I**	**Duration**	**:**	**3 Hrs**

Instruction to the Candidate: Answer one full question from each section.

Q.No	Question	CL	CO	Marks
	Section-1			
1.a)	Illustrate all necessary sensors in a flight controller and mentions its importance.	L3	1	10
b)	Distinguish between a bull nose and a tapered tip propeller (any 3)	L4		10
2.a)	Distinguish between a companion computer and a flight controller(any 5)	L4		10
b)	Explain in detail the application of drones for e-commerce delivery	L3		10
	Section-2			
3.a)	What type of UAV would use select for a long endurance surveillance mission and why?	L3	2	10
b)	Analyse any 5 pre-arm check errors and explain how to fix those issues.	L4		10
4.a)	Sketch the schematic of the transmission system of a drone and ground station including a control, FPV and telemetry system.	L3		10
b)	Mention 5 drone companies and explain their product and targetted market.	L4		10
	Section- 3			
5.a)	Draw the schematic of a PID cotroller and mention the formula for error calculation	L3	3	10
b)	Analyse any 3 failsafe triggers and its responses.	L4		10
6.a)	Mention 3 rapid prototyping machinery and its benefits.	L3		10
b)	Illustrate any 5 flight modes available on ardupilot and its uses.	L4		10
	Section-4			
7.a)	What would be the difference in performance between a quad-blade and a bi-blade propeller of the same size and type?	L4	4	10
b)	Mention 3 payloads that a first responder would require during an emergency	L3		10
8.a)	What current capacity will you charge a 3S 2500mAh 50C battery at 2C and what would be the max current output of the battery?	L4		10

b)	Calculate the rpm of a 1750kv running from a 6S battery discharged upto 30% of its capacity	L3		10
Section-5				
9.a)	How will you solve the vibration issue if the blackbox shows a low frequency oscillation on 10% throttle on the pitch axis?	L4	5	10
b)	Explain in detail all preflight checks needed before a flight in a yellow zone.	L3		10
10.a)	How would you diagnose the issue of the receiver inputs not being detected even though the the receiver and transmitter is bound to each other	L4		10
b)	Mention the sub systems and procedures needed to check during a maintenance cycle.	L3		10

Scheme of Evaluation for SEE 2

Sl. No	Description	Marks
	a)Write and execute a code on a raspberrypi which can make the drone stop when the ultrasonic sensor detects an obstacle under 1 meter b)Design a co-axial motor mount for a 2306 motor having 16mm diameter 3 mounting holes with a 6" tri blade propeller c)Estimate the endurance of a X8 setup with a 1800Kv motor and 5000Ah 6S Li-ion battery and having the all up weight of 2500g d) Configure the drone on mission planner to fly to 3 different waypoints at different altitudes and speed	
1	Code development	20
2	Thrust and endurance calculation	20
3	Design validation	20
4	Configuration and setup	20
5	Viva voce	20

Equipment / Software List with specification for a batch of 20 students.

Sl No	Equipment's	Specification	Quantity
1	Simulator Kit	Transmitter, Battery, Charger, Case, Cable, Drone piloting simulator software.	1
2	Nano drone Kit	Nano drone, Battery, Battery Charger, Propeller spares, Sensors.	1
3	Thrust stand	Thrust stand, Motors, Propellers, Speed controllers, Battery, Chargers.	1
4	Industrial drone	Frame, Motors, Propellers, Speed controllers, Flight controllers, GPS, Telemetry, Transmitter, Receiver, Battery, Charger, Tools, VRX, FPV Camera. Antenna, VTX, Node MCU, Raspberry Pi Kit, LORA,3D Printer, Filament.	1
5	Prototype kit	3D Printer, Filament, Tools, Open-source design software.	1

Industrial Internet of Things (IIoT)

Government of Karnataka

DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Program	**Electronics & Communication Engineering**	**Semester**	**5**
Course Code	**20EC52I**	**Type of Course L:T:P**	**104 : 52 : 312**
Specialization	**Industrial Internet of Things (IIoT)**	**Credits**	**24**
CIE Marks	**240**	**SEE Marks**	**160**

Rationale:

The industrial internet of things (IIoT) is the use of smart sensors and actuators to enhance manufacturing and industrial processes. Also known as the industrial internet or Industry 4.0, IIoT leverages the power of smart machines and real-time analytics to take advantage of the data that dumb machines have produced in industrial settings for years. The driving philosophy behind IIoT is that smart machines are not only better than humans at capturing and analysing data in real time, they are better at communicating important information that can be used to drive business decisions faster and more accurately.

Pre-requisite

Before the start of this specialization course, you will have prerequisite knowledge gained in the first two years on the following subjects:

1st year -Engineering Mathematics, Communication Skills, Computer Aided Engineering Graphics, Statistics & Analysis, Basic IT Skills, Fundamentals of Electrical and Electronics Engineering, Project Management skills, Digital Electronics

2nd year- Analog Electronics, Logic Design using Verilog, Communication Systems, Electronic Measurements and Testing Techniques, PCB Design & Fabrication, Wireless Communication, Embedded C Programming, Industrial Automation, in this year of study, you shall be applying your previous years learning along with specialized field of study into projects and real-world applications.

Instruction to course coordinator.

1. Each Specialized field of study is restricted to a Cohort of 20 students which could include students from other relevant programs.
2. One faculty from the Core Discipline shall be the Cohort Owner, who for teaching and learning in allied disciplines can work with faculty from other disciplines or industry experts.
3. The course shall be delivered in boot camp mode spanning over 12 weeks of study, weekly developmental assessments and culminating in a mini capstone.
4. The industry session shall be addressed by industry experts (in contact mode/online / recorded video mode) in the discipline only.
5. The cohort owner shall be responsible to identify experts from the relevant field and organize industry session as per schedule.

6. Cohort owner shall plan and accompany the cohort for industrial/mines/site/showroom/service Centre visits.
7. Cohort owner shall maintain and document the industrial assignments, weekly assessments, practices and mini project.
8. The cohort owner shall coordinate with faculties across programs needed for their course to ensure seamless delivery as per time table
9. The cohort owner along with classroom can augment or use for supplementally teaching on line courses available although reliable and good quality online platforms like Karnataka LMS, Infosys Springboard, NPTEL, Unacademy, SWAYAM etc.
10. Report should be maintained for industrial/field visit, such report shall be considered as industrial assignment.

Course outcomes:

On successful completion of the course, the students will be able to,

CO1	**Explain the concept of Industrial Internet of Things (IIoT), components and its known applications.**
CO2	**Demonstrate use cases of IIoT systems, for any applications using protocols & networks.**
CO3	**Build a cloud based IIoT system for a specific application & verify its output.**
CO4	**Demonstrate the importance of IIoT data analytics & IIoT security in various industries/sectors.**
CO5	**Design, test and troubleshoot a given IIoT system to meet defined operational specifications in real and simulated environment.**

Detailed course plan

Week	C O	P O	Days	1st session (9am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
1	**Learning Outcomes**			**1. Introduction to IIoT.** **2. Information technology (IT), Operational technology (OT) & convergence.** 3. **Simple application of wifi module: NODEMCU ESp8266**							
	1	1,5,7	1	Industrial Revolutions 1,2, 3. Globalization and Emerging issues. Fourth Industrial Revolution. Industry 4.0 concepts, benefits. Applications of Industry 4.0 – video demonstration. Difference between IoT and IIoT, IoT node. Globalization and Emerging Issues of IIoT.	2		2	IIoT- Concept, definitions & Implementation Examples - Embedded Systems, Computer Networks, Internet of Everything (IoE).	1		2
			2	Interoperability, Identification, localization, Communication, Software Defined Assets. IIoT application in various sectors/industries: Agriculture, Energy, Finance, Healthcare, Manufacturing, hospitality, Transportation & Logistics. Retail, etc. **Practise** Demonstration & explanation of IIoT applications in various sectors.	1		3	Evolution of IIoT, IIoT Adoption. Information Technology (IT) &Operational Technology (OT)– introduction, convergence, connected factory, advantages.	1	1	1
			3	Operational Technology (OT) components: industrial control system, PLC, SCADA, DCS. IT Components (IT): Hardware, Software, People, Processes. **Practise** Demonstration of OT & IT components and processes in various domains.	2		2	Basics of wireless networking, introduction to ESP8266 Wi-Fi Module, study datasheet. **Practise** Introduction to NODEMCU ESp8266(WIFI module) & its simple implementation.			3

			4	Smart factory applications and smart warehousing – concept, implementation, use case demonstration. Safety and health (conditions) monitoring of workers.	1		3	Predictive and remote maintenance –concept, implementation use case. Demonstration of maintenance process.	1		2
			5	Assess students for understanding of fundamental concepts – **Developmental Assessment**				Assessment Review and corrective action			3
			6	**Industry Class** on introduction to IIoT.	2		2	Weekly Assignment(1PM-2PM)			1
2	**Learning Outcomes**			**Application of IIoT in different sectors- Use Cases**								
	1,2	1,3,7	1	Tutorial (Peer discussion on Industrial assignment)		4		Smart metering and smart grid – concept, demonstration, use cases.	1	1	1
			2	Freight, goods and transportation monitoring - concept, implementation, use cases. Smart city – use case.	1	1	2	Industrial heating, ventilation and air conditioning (HVAC), Manufacturing equipment monitoring - concept, implementation, demonstration, use cases.	1		2
			3	Asset tracking and smart logistics. Ozone, gas and temperature monitoring in industrial environments - concept, implementation, demonstration, use cases. Remote service, field service, remote maintenance and control use cases.	1		3	Smart environment solutions - concept, demonstration, use cases.	1		2
			4	Data, Information, Knowledge and Wisdom realization for an organisation. (DIKW) – concept, model & examples. DIKW pyramid and relevance with IoT. Explain with an example.	1	1	2	History and evolution of automation: Plants to Parts. Comparison between IoT & automation. IIoT in automation.	1		2
			5	**Developmental Assessment**				Assessment Review and corrective action			3
			6	**Industry Class** – Use cases of IIoT.	2		2	Weekly Assignment(1PM-2PM)			1

3	**Learning outcomes**		**1. Automation concepts.** **2. Industry visit.**								
	1,2	1,3	1	Tutorial (Peer discussion on Industrial assignment)		4		Commercial microcontroller-based development boards- examples, selection criteria and trade-offs for automation.	1		2
			2	Machine to Machine (M2M) networks- M2M towards IoT-the global context, concept, components, examples.M2M Value Chains, IoT Value Chains. Comparison between M2M & IoT. Industrial networks – concept, type, examples. Demonstration of M2M networks &Industrial networks	1		3	Human Machine Interface (HMI) in an automation process – concept, implementation, examples. Enterprise Resource Planning (ERP)- concept, implementation. Integration of IIoT with ERP systems. Manufacturing Execution System (MES) – concept, implementation, cloud MES	1		2
			3	**INDUSTRY VISIT:** Visit nearby **automation industry** and see how IIoT is implemented there, Prepare a detailed report on the components used, the process, the data storage and analysis, etc of the respective industry.			4	**INDUSTRY VISIT:** Visit nearby **automation industry** and see how IIoT is implemented there. Prepare a detailed report on the components used, the process, the data storage and analysis, etc of the respective industry & demonstrate a presentation.			3
			4	IIoT Protocols – need of protocols, types. Modbus protocol and Profibus protocol – introduction, working, applications. Communication Protocols: Near – field communication (NFC), RFID, Low Power Wide Area Network (LPWAN) technology - introduction, features.	1		3	Identify the list of protocols used across various industries/sectors and prepare a report. **Practise** Demonstration of LoRAWAN communication.	1		2

			5	**CIE 1 – Written and Practice Test**				Assessment Review and corrective action			3
			6	**Industry Class –** M2M & industrial networks.	2		2	Weekly Assignment(1PM-2PM)			1
4	**Learning Outcomes**			**IIoT Ecosystem: networks & protocols.**							
	1,2	1,3,4	1	Tutorial (Peer discussion on Industrial assignment)		4		**Practise** IoT protocol stack - with hands-on such as Contiki-OS or any other IoT based stack.	1		2
			2	Industry standards communication technology: LoRAWAN, OPC unified architecture (UA), Message Queuing Telemetry Transport (MQTT) – introduction, features. **Practise.** Design/simulate/demonstrate a simple MQTT protocol-based system. The Cloud application should fetch data from a device using the MQTT protocol.	1		3	**Practise** Interfacing 4G GSM Modem to communicate b/w the devices using Arduino/raspberry Pi/Node MCU.			3
			3	Industrial Control System – Introduction, Fundamentals, Components, examples, advantages. How IIoT Enhances Industrial Control Systems, explain with examples (Oil & gas IIoT, Airports IIoT, etc)	1		3	Demonstration of IIoT networks & protocols Prepare a report on the networks and protocols used in various industries and demonstrate.			3
			4	Zigbee communication mechanism: device types, operation, network topologies, applications.	1		3	**Practise** – simulation of IIoT Networking models using	1		2

				Practise – simulation of IIoT Networking models using Tools. (Cisco packet tracer, wireshark, netsim etc.)				Tools. (Cisco packet tracer, wireshark, netsim etc.)			
			5	**Developmental Assessment**				Assessment Review and corrective action			3
			6	**Industry Class on** networks and protocols.	2		2	Weekly Assignment (1PM – 2PM)			1
	Learning Outcomes			1. **Introduction to IoT platforms.** 2. **Gateways & Cloud concepts.**							
5	2,3	3,4,7	1	Tutorial (Peer discussion on Industrial assignment)		4		centralized vs distributed network architectures. Wireless Fidelity communication mechanism (Wi-Fi) - types, protocols, applications. Bluetooth communication mechanism: versions, components, operation and applications	1		2
			2	Narrow Band Internet of Things (NB-IOT) communication mechanism - components, operation and applications. **Practise** – simulation of IIoT communication models using Tools. (Cisco packet tracer, wireshark, netsim etc.)	1		3	IPv6 over Low-power Wireless Personal Area Networks(6lowpan) communication mechanism - operation and applications. **Practise** – simulation of IIoT communication models using Tools. (Cisco packet tracer, wireshark, netsim etc.)	1		2
			3	**Practise** Introduction to Blynk IoT platform – features. cloud, installation, steps to execute experiments.	1		3	**Practise** Design a simple IoT based application using Blynk IoT platform.			3
			4	Industrial Gateways – Concept, Types. Commercial Gateways solutions from Intel, Cisco –concept, features, advantages. Payment Gateway demonstration from any e commerce companies.	1		3	Cloud service models: Infrastructure as a service (IaaS) model, Software as a service (SaaS) model, Platform as a service (PaaS)model – concept, comparison, applications.	1		2

				Cloud – introduction, cloud computing: concept, benefits, types. Cloud demonstrations.				Cloud service models: demonstrations.			
			5	**CIE 2 – Written and Practice Test**				Assessment Review and corrective action			3
			6	**Industry Class** on gateways and cloud concepts.	2		2	Weekly Assignment (1 PM-2PM)			1
6	**Learning Outcomes**			**Cloud services.**							
	3	1,3,4,5	1	Tutorial (Peer discussion on Industrial assignment)		4		Cloud storage: working operation, benefits, challenges. deployment models – private cloud storage, public cloud storage, hybrid cloud storage, Community cloud storage – features, comparison, examples.	2		1
			2	Introduction to Arduino Cloud software. Explore its features like configuration of devices, connecting to network, writing code, uploading, dashboard creation, visualization. **Practise** Design Arduino IoT Cloud ESP8266 NodeMCU Alexa Home Automation system/Alexa class room automation system.	1		3	**Practise** Design Arduino IoT Cloud ESP8266 NodeMCU Alexa Home Automation system/Alexa class room automation system.			3
			3	cloud computing services: concept, types. Amazon Web Services (aws), Azure, Google Cloud Platform(gcp) - features. **Practise** Demonstration & explanation of AWS Service.	1		3	Amazon Web Services (AWS) – benefits, use cases (any 3), applications.	1		2

			4	EDGE Devices – Architecture, programming & Communication with other devices, Local database in the Edge device, examples. Edge computing: need, applications. demonstration of edge computing.	2		2	IoT architecture: smart devices, sensors/devices. connectivity, data processing, cloud platforms, user interface – demonstrate the flow of data in all the stages. Enterprise data for IIoT. Emerging descriptive data standards for IIoT.	2		1
			5	**Developmental Assessment**				Assessment Review and corrective action			3
			6	**Industry Class on** cloud services **.**	2		2	Weekly Assignment (1PM-2PM)			1
7	**Learning Outcomes.**			**Design considerations & development of IIoT systems.**							
	3,5	1,2,3,5	1	Tutorial (Peer discussion on Industrial assignment)		4		Industrial Internet Reference Architecture (IIRA) from Industrial IoT Consortium (IIC) – concept, features, role of IIC in shaping IIOT's. Standardization initiatives. Interoperability issues.	2		1
			2	IIoT design considerations - architecture, device, network and cloud, explain with an example and demonstrate. Build partnerships. Clarify business outcomes and Return on Investment (ROI). Start small, Security first. design philosophy: IIoT for industrial processes, features of industrial process & its benefits.	1	1	2	components of futuristic industrial plant in industry 4.0 with block diagram. Suggest the requirements to develop a facial recognition door unlock IoT project for your home and prepare a report on the IoT architecture - development of the system and demonstrate in class.			3
			3	Introduction to ThingSpeak software – data aggregation & analysis, features, usage, applications.	1		3	**Practise** Show with a practical example with the use of Arduino uno and sensor of your choice how			3

				Practise Show with a practical example with the use of Arduino uno and sensor of your choice how data can be sent to a thingspeak cloud and analyse the data.				data can be sent to a thingspeak cloud and analyse the data.			
			4	**Practise** Design an IoT based Water Level Indicator Model Using Ultrasonic Sensor, NodeMCU and display the water level on the webserver.			4	Data analytics for IoT - concept, types & applications. Benefits, Real time analytics.	2	1	
			5	**CIE 3 – Written and Practice Test**				Assessment Review and corrective action			3
			6	**Industry Class** on design of IIoT Systems	2		2	Weekly Assignment (1PM – 2PM)			1
8	**Learning Outcomes.**			**IIoT Data Analytics.**							
	4,5	1,2,3,5,7	1	Tutorial (Peer discussion on Industrial assignment)		4		IoT based data acquisition systems (DAS) – Concept, Components, Block Diagram, Tools, Storage. demonstration & explanation of an DAS application.	2		1
			2	Impact of data analytics on various industries/sectors - Smart Grids, Connected HealthCare System, Smart Farming, Smart Barcode Readers, Smart Supply Chain Management. Explain the importance of data analytics in each sector to gain operation efficiency. (Any 3 sectors with examples), demonstrations.	1	1	2	ThingSpeak IoT analytics platform – introduction, features, demonstration. **Practise** Design an IoT Based Temperature and Humidity Monitoring over ThingSpeak using Arduino UNO and ESP8266 at various times in a day.	1		2
			3	Edge analytics - Data Aggregation on Edge gateway. **Practise** Create the analytics report for the already designed - IoT Based Temperature and	1		3	Understanding fundamental nuances between IoT and Big data – use case & demonstration. Big data analytics role in IoT – concept, applications, benefits.	1		2

				Humidity Monitoring and analyze the data.							
			4	Smart Factory –application areas, Function blocks, interfaces, Top-down control and design Challenges for industrial processes in industry 4.0.	2	1	1	**Practise** Build an IoT Based Colour Sorting Machine using ESP8266 and ThingSpeak software.			3
			5	Developmental Assessment				Assessment Review and corrective action			3
			6	**Industry class** on IIoT data analytics.	2		2	Weekly Assignment (1PM-2PM)			1
9	**Learning Outcomes.**			**Cyber-physical systems (CPS) & Cybersecurity.**							
	4	1,3,5,7	1	Tutorial (Peer discussion on Industrial assignment)		4		Cyber physical systems – Scope, features, examples, applications. Demonstration of Cyber security awareness videos and an CPS application. Prepare a report on Do's and don'ts, general precautions to be taken while using the internet.	2		1
			2	**Practise** IoT simulation software /hardware -based activities/demonstration on cyber physical systems for any application. Prepare a report for the application considered with all the details.			4	Cybersecurity – security concerns, examples. CPS protection from Cyber Threats. Hacking as the biggest Threat, Types, Examples & Demonstration. **Practise** Demonstration/simulation of a cyber threat/hacking scenario & solutions on any sector/industry	2		1
			3	IoT Related Issues related to Security, Network Level Problems/Insecurities, Importance of Windows Firewall.	1		3	hardware & software solutions, open-source initiative.	2		1

				vulnerabilities – concept, types. attack surfaces – concept, types, reduction techniques, demonstration. **Practise** Demonstration/simulation of a vulnerability scenario (firewall/attack surfaces) using video/software.				**Practice** Demonstration/simulation of solutions to vulnerability scenario using video/ software.			
			4	Next generation sensors in industry 4.0 (intelligent sensors)– limitations of smart sensors, need for next generation sensors, advantages, applications. Industrial Internet Systems – elements, applications, Examples. Impact of industrial internet on health care sector. **Practise** video demonstration of industrial internet systems for any application	1		3	Industrial Internet Systems – advantages, Use Cases. **Practise** video demonstration of industrial internet systems for any application	1		2
			5	**CIE 4 – Written and Practice Test**				Assessment Review and corrective action			3
			6	**Industry class** on cyber physical systems & cybersecurity.	2		2	Weekly Assignment(1PM-2PM)			1
10	**Learning Outcomes**			**IIoT Testing & troubleshooting.**							
	4,5	2,3,7	1	Tutorial (Peer discussion on Industrial assignment)		4		IoT device applications – examples. OS hardening – concept, methods. Demonstration.	2		1
			2	Network and protocol security – need, concept, types, features. Cloud security- need, concept, working	2		2	**Practise** Demonstration of cloud security process for any application. Explain the concept involved.			3

				principle, best practices. IoT Security challenges – Types.							
			3	Case study: two case studies on recent IoT/IIoT related security attack. Prepare a report on the vulnerabilities that were exploited by cyber criminals and how it affected a particular sector/organization, etc from the above case studies.	2		2	IoT Testing: introduction, testing areas – connectivity, compatibility, security, functionality, performance, exploratory features of any given application.	1		2
			4	IoT troubleshooting: concept, parameters, importance of troubleshooting steps - connectivity, compatibility, security, functionality, performance involved for an effective IIoT project. **Practise Exercise** Perform simulations/hardware-based optimization, test & troubleshoot to get the desired output for any application of your choice.]	1		3	Contd.			3
			5	**Developmental Assessment**				Assessment Review and corrective action			3
			6	**Industry Class** on testing ,troubleshooting IIoT systems.	2		2	Weekly Assignment (1PM-2PM)			1
	Learning Outcomes			**IIoT optimizations.**							
11	4, 5	1,2,3,4,7	1	Tutorial (Peer discussion on Industrial assignment)		4		Collaborative Platform – concept, implementation. Product Lifecycle Management – concept, stages. Business objectives,	2		1
			2	Machine Learning & Artificial Intelligence in IoT-concept, applications, use case. Explanation and demonstration of Machine Learning & Artificial Intelligence.	1		3	Collect, study and prepare a report on the ways in which IoT is implemented in Agriculture & Livestock monitoring, Prepare models/prototypes to demonstrate the agricultural IoT in class.	1		2

			3	Augmented Reality and Virtual Reality role in IoT -concept, use case, comparison, applications. Explanation and demonstration of Augmented Reality and Virtual Reality.	2		2	Case study: Health monitoring using IoT. Demonstrate IoT Based Health Monitoring System using Raspberry Pi.	1		2
			4	Design & analyse of smart irrigation system using Blynk software, NodeMCU, and soil moisture sensors and demonstrate the output. (How to build a IOT Smart Irrigation System with Blynk software, NodeMCU, and Soil Moisture) **- components, demonstration & explanation.**			4	Contd.			3
			5	**CIE 5 – Written and Practice Test**				Assessment Review and corrective action			3
			6	**Industry Class** on optimizations in IIoT.	2		2	Weekly Assignment(1PM-2PM)			1
12	**Learning Outcomes.**			**IIoT Applications.**							
	3,4,5	2,3,5,7	1	Tutorial (Peer discussion on Industrial assignment)		4		Revisiting an IIoT system's architecture in general with the necessary and mandatory components required for the design of an application for any sector. Prepare a report on the design requirements of an IIoT system for an application in any sector/industry.	2		1
			2	IIoT based smart energy meter/ Smart Baggage Tracker/ Automation using controller via Bluetooth simulation/hands on/ demonstration of components, technology & process.	2		2	IIoT based smart energy meter/ Smart Baggage Tracker/ Automation using controller via Bluetooth/– simulation/hands on/ demonstration of components, technology & process.	1		2

			3	Design and analysis of IoT Based Smart Car Parking System Using Arduino, NodeMCU& Blynk app.			4	Contd.			3
			4	Design the Temperature based Touchless Attendance System using NodeMCU and MLX90614 Infrared Thermometer and display the results in the web server.			4	Contd.			3
			5	**Developmental Assessment**				Assessment Review and corrective action			3
			6	**Industry Class** on IIoT applications.	2		2	Weekly Assignment(1PM-2PM)			1
13											
			1	**Internship** a) Secondary research on various industries and their operations to identify at least 3 companies along with the areas of work interest and develop an internship plan that clearly highlights expectations from the industry during the internship. b) Design and develop a cover letter for an internship request to all 3 identified companies and the resume to be submitted to potential companies. c) Prepare for an internship interview to highlight your interests, areas of study, career aspirations and personnel competence – including the areas of learning you expect to learn during internships Review			4	**Project** a) Identification of the problem statement (from at least 3 known problems) the students would like to work as part of the project – either as provided by faculty or as identified by the student. Document the impact the project will have from a technical, social and business perspective. b) Design and develop the project solution or methodology to be used to solve at least one of the problems identified. c) Prepare a project plan that will include a schedule, WBS, Budget and known risks along with strategies to mitigate them to ensure the project achieves the desired outcome			3
			2				4				3
			3				4				3
			4				4				3
			5				4				3
			6				4				1

Note:

1. **Practice Exercises (Hands on) should be done using hardware development boards like Arduino/NODEMCU/Raspberry Pi along with the necessary sensors/jumper wires/breadboards/components.,etc**
2. **Simulation exercises can be done using tools such as Netsim, Cisco packet tracer, wireshark, etc.**
3. **Study the datasheets for various sensors and other new components mentioned in the practice exercises and learn how to use them.**

REFERENCES.

Sl. No	Description
1	The Internet of Things in the Industrial Sector, Mahmood, Zaigham (Ed.) (Springer Publication)
2	Industrial Internet of Things: Cybermanufacturing System, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer Publication)
3	Industrial IoT Challenges, Design Principles, Applications, and Security by Ismail Butun (editor) Springer Publications.
4	Industry 4.0 The Industrial Internet of Things by Alasdair Gilchrist, Apress Publications.
5	Rahul Dubey, “An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications”, Cengage India Publication
6	Perry Xiao, “Designing Embedded Systems and the Internet of Things (IoT) with the ARM Mbed
7	Sudip Misra, Chandana Roy and Anandarup Mukherjee, “Introduction to Industrial Internet of Things and Industry 4.0”, CRC Press
8	G Veneri Antonio, “Hands-on Industrial Internet of Things”, Packt Publication.
9	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, CISCO Press, 2017
10	Massimo Banzi, Michael Shiloh Make: Getting Started with the Arduino, Shroff Publisher/Maker Media Publishers.
11	Richardson, M., & Wallace, S. (2012). Getting started with raspberry PI. " O‟Reilly Publisher Media, Inc
12	design a system using Arduino uno and esp 8266 wifi module to create a smart irrigation system for your home / college garden. design the whole system with proper block diagram, wiring and code.
13	Show with a practical example with the use of Arduino uno and sensor of your choice how data can be sent to a thingspeak cloud https://create.arduino.cc/projecthub/adhyoksh/iot-with-thingspeak-8d3848

14	IoT Based Temperature and Humidity Monitoring over ThingSpeak using Arduino UNO and ESP8266 https://iotdesignpro.com/projects/temperature-humidity-monitoring-over-thingspeak-using-arduino-esp8266
15	Arduino IoT Cloud ESP8266 NodeMCU Alexa Home Automation system. https://www.youtube.com/watch?v=UtReFcOLJx8 (week 6 day 2)
16	IoT based Home Automation project using NodeMCU ESP8266 and New Blynk app |
17	AWS In 10 Minutes | AWS Tutorial For Beginners | AWS Training Video | AWS Tutorial | Simplilearn - YouTube (week 6 ,day 3)
18	What is edge computing? - YouTube (week 6, Day 4)
19	IoT Based Health Monitoring System using Raspberry Pi - YouTube (week 11, Day 3)
20	How to build a IOT Smart Irrigation System with Blynk, NodeMCU, and Soil Moisture - YouTube (Week 11,day 4)
21	Arduino Project: IOT Car Parking System using Nodemcu esp8266 wifi + Blynk (Tabs + led widgets) - YouTube (week 12, day3)
22	Temperature based Touchless Attendance System using NodeMCU and MLX90614 Infrared Thermometer https://iotdesignpro.com/projects/temperature-based-touchless-attendance-system-using-nodemcu-and-mlx90614-infrared-thermometer
23	https://iotdesignpro.com/projects/iot-based-colour-sorting-machine-using-esp8266-and-thingspeak

CIE and SEE Assessment Methodologies

CIE Assessment	Assessment Mode	Duration In hours	Max Marks
Week 3	CIE 1– Written and practice test	4	30
Week 5	CIE 2– Written and practice test	4	30
Week 7	CIE 3– Written and practice test	4	30
Week 9	CIE 4– Written and practice test	4	30
Week 11	CIE 5– Written and practice test	4	30
	On line Course work (Minimum 10 hours online course with certification from (SWAYAM/NPTEL/Infosys Springboard)		40
	Profile building for Internship / Submission of Synopsys for project work		20
Portfolio evaluation (Based on industrial assignments and weekly developmental assessment) *			30
TOTAL CIE MARKS (A)			**240**
SEE 1 - Theory exam (QP from BTE) Conducted for 100 marks 3 hrs duration reduced to 60 marks		**3**	**60**
SEE 2 – Practical		**3**	**100**
TOTAL SEE MARKS (B)			**160**
TOTAL MARKS (A+B)			**400**

***** The industrial assignment shall be based on peer-to-peer assessment for a total of 10 marks (on a scale of 1 to 10) and in the event of a group assignment the marks awarded will be the same for the entire group, the developmental assessment will be for a total of 20 marks and based on MCQ/case study/demonstration and such other assignment methods

Assessment framework for CIE 3 (1 to 5)

Note : Theory to be conducted for 1 hour and practice for 3 hours, total duration of exam – 4 hours

Programme	**Electronics & Communication Engineering**	**Semester**	**V**
Course	**Industrial Internet of Things (IIoT)**	**Max Marks**	**30**
Course Code	**20EC52I**	**Duration**	**4 hours**
Name of the course coordinator			

Note: Answer one full question from each section.

Qn.No	Question	CL L3/L4	CO	PO	Marks
	Section-1 (Theory) – 10 marks				
1.a)	NASA (National Aeronautics and Space Administration) has always wondered about creating a library to present people with all its achievements through pictures and videos of space. Later on, it created such platforms, but because it had 10 different NASA centers, it couldn't provide the best experience for viewers. So, all it wanted was to create an easy-access platform for people to search for and view images and videos. How did NASA handle this situation. Which web services were used, mention its features.	L4	1,3	1,3,4,5	5
b)	'Insecure cloud services' is a type of cloud vulnerability. Do you agree? Justify your answer.	L3	1,3	1,3,4,5	5
2.a)	Lack of security support on devices deployed in production of a manufacturing plant, including asset management, update management, secure decommissioning, systems monitoring, and response capabilities: is security support on IoT devices essential? Justify your answer.	L4	3,5	1,2,3,5	5
b)	Vulnerabilities are a major and constant issue in the field of the IoT. It can come from any layer of IoT devices severely affecting the business operations of all the industries. As a systems engineer what steps would you take to secure the organisation from malwares, adwares , Trojans,etc. prepare an document for the best practices to be used by all the employees of an organization.	L4	3,5	1,2,3,5	5
	Section-2 (Practical) - 20 marks				
3)	Design Arduino IoT Cloud ESP8266 NodeMCU Alexa Home Automation system/Alexa class room automation system.	L4	1,3	1,3,4,5	20
4)	Show with a practical example with the use of Arduino uno and sensor of your choice how data can be sent to a thingspeak cloud and analyse the data.	L3/l4	3,5	1,3,4,5	20

Note : Theory questions shall be aligned to practical questions

Assessment framework for SEE 1 (Theory)

Programme	**:**	**Electronics & Communication Engineering**			
Semester	**:**	**V**			
Course	**:**	**Industrial Internet of Things (IIoT)**	**Max Marks**	**:**	**100**
Course Code	**:**	**20EC52I**	**Duration**	**:**	**3 Hrs**

Instruction to the Candidate: Answer one full question from each section.

Q. No	Question	CL	CO	Marks
	Section-1			
1.a)	Predictive maintenance is an effective solution to avoid unnecessary downtime in the production line. Do you agree? Justify your answer with an example from energy sector.	L3	1	10
b)	Given the breadth of operation technology (OT) in manufacturing, the modern factory often includes many machines, devices, and control mechanisms operating in relative isolation, and communicating using a variety of niche protocols. This has created silos, communication difficulties, and blindspots in processes. How can this condition be improved in IIoT to better work with the Information technology (IT) components.	L4		10
2.a)	Modern industrial machines equipped with "devices" continuously monitoring the status of each major components and it can detect any critical issues before the system is completely down. Who will trigger maintenance warning to the centralized system and what are the subsequent actions that are followed? Which technology is followed. Explain in detail.	L3/L4		10
b)	Explain the necessity of adopting IoT technology for a growing need to increase customer loyalty and deliver the best in-store experience by retail sector in the following sectors: (i) Inventory management (ii) Smart payments (iii) Smart vending machines.	L3/L4		10
	Section-2			
3.a)	This protocol has formed the foundation of data communication over the web. It is the most common protocol that is used for IoT devices when there is a lot of data to be published. Which is this IoT network protocol? why is it not a preferred choice nowadays? Which protocol would you suggest for Additive manufacturing/3D printing process for an industry. List its features.	L4		10

b)	The cloud architect of ABB company has informed you to select the best communication protocol to be used in smart cities, where there are millions of devices that function with less power and memory. Which protocol would you suggest and why? Which protocol is used for smart street lighting in a smart city.	L3	2	10
4.a)	Which is the most preferred protocol for IoT devices, say for example fire detectors? It should support remote monitoring and used in devices which are economical and requires less power and memory. Explain its working principle.	L4		10
b)	In an SBI ATM, a customer needs to withdraw Rs 15000/- cash. On entering the details, the ATM Kiosk asks for the PIN as it is over Rs 10,000/- withdrawal The customer does get the OTP message from the bank, enters the data, collects the receipt with the updated balance. However, the ATM KIOSK does not ask for an OTP for transactions below Rs 10,000/-? Where is the checkpoint happening in the communication between SBI and customer. Elaborate your answer with details.	L3/L4		10
Section- 3				
5.a)	An organization debating whether to install a private cloud or to use a public cloud, e.g., the AWS, for its computational and storage needs, asks your advice. What information will you require to base your recommendation on? list the requirements that needs to be considered for using the cloud services.	L3	3	10
b)	Overprovisioning is the reliance on extra capacity to satisfy the needs of a large community of users when the average-to-peak resource demand ratio is very high. Give an example of a large-scale system using overprovisioning and discuss if overprovisioning is sustainable in that case and what are the limitations of it. Is cloud elasticity based on overprovisioning sustainable? Give the arguments to support your answer	L4		10
6.a)	SAP is a really big company, so much so that its offerings span multiple service models. Among them is their Cloud PaaS which is an open business platform. It was designed to help developers build applications more easily, offering both breadth and depth of service. What features are offered by PaaS model which is beneficial to SAP company. Explain its features.	L4		10
b)	In financial sector, the E – payments made by the customer are failing repeatedly. What could be wrong? Explain how gateways are used for data management, local applications and device management in IoT.	L3		10
Section-4				
7.a)	Illustrate the role of the Internet of Things for Increased Autonomy and Agility in Collaborative Production Environments for Logistics & Supply Chain Optimization in manufacturing sector?	L3		10
b)	Siemens is a German multinational conglomerate company. The company builds automated machines for the likes of BMW. Siemens introduced an operating system called Mindsphere, the cloud-based IoT unit from Siemens which basically aggregates the data from all the different vital components of a factory and then processes them through rich analytics to produce useful results. Suddenly, the	L4		10

	operating system was behaving weirdly and started to give inaccurate data / links were popping up , as if the system was hanging and it was noticed by the system engineers. What could have gone wrong? how to control the situation.		4	
8.a)	Fanuc is one of the largest suppliers of industrial automation equipment in the world. The company had developed FIELD System (Fanuc Intelligent Edge Link & Drive System), an open platform that enables the execution of various IIoT applications that focus on heavy devices like robots, sensors, and machine tools. How are supervisors in Fanuc able to anticipate any failure in the mechanism and keep up with the schedule and reduce costs. Elaborate on the methods being used.	L4		10
b)	In the healthcare industry (Medical IoT) IoT devices are already being utilized to remotely monitor patients' vital signs and has proven very helpful since the pandemic . what are the possible consequences of IoT security attacks in Medical IoT.	L4		10
	Section-5			
9.a)	Heavy-equipment maker Caterpillar has long been an IoT projects pioneer. It wants to give the machine operators an at-a-glance view of everything from fuel levels to when air filters need replacing. If an old filter expires, the company can send basic instructions for how to replace it via an AR app. Recommend the technology can be adopted by Caterpillar to meet its desired requirements and improve the efficiency.	L4	5	10
b)	Amazon is already using the smart warehouse at the beginning stage. Explain the deployment and operational view, resources, services, virtual entities, users in an IoT system by considering a smart warehouse as an example.	L3		10
10.a)	Netflix is an entertainment platform that started in the United States, but eventually, it expanded to many countries and soon became popular. How could Netflix confront the scalability problem with the sudden increase in viewers. What kind of databases were used and what were the other services offered by the solution to the scalability problem. Compare this with Disney Hotstar and list the differences.	L4		10
b)	McDonald's is the world's largest fast-food company that serves around 64 million people per day. The growth of this company has gone to another level when it started home deliveries. McDonald's created a platform that integrates local restaurants with delivery partners such as Uber Eats, Swiggy & Zomato. McDonald's platform can scale 20,000 orders per second and integrate with the global partners easily. How can McDonald's manage such a higher number of orders every day?	L4		10

Scheme of Evaluation for SEE 2

Sl. No	Description	Marks
	Problem statement: Design a IIoT system for a given application with cloud interfacing and show the output. (Any development board NODEMCU ESP 8266/ Arduino/raspberry pi can be used). troubleshoot if required to get the desired output.	
1	Components required & assembly of circuit diagram in hardware.	20
2	Writing code for Cloud interfacing and initialization. **(**Programming Arduino for Sending data to cloud)	30
3	Conduction of the experiment.	20
4	Troubleshooting steps taken/ Results	20
5	Viva voce	10
Total		**100**

Equipment / Software List with specification for a batch of 20 students.

Sl No	**Equipment's**	**Quantity**
1	Arduino Boards	5
2	NODEMCU Esp8266	5
3	Raspberry Pi Boards	2
4	Jumper Wires.	As per requirement
5	Related Sensors /components to Practise Exercises.	As per requirement

Automation & Robotics

Government of Karnataka

DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Program	**Electronics & Communication Engineering.**	**Semester**	**5**
Course Code	**20EC53I**	**Type of Course L:T:P**	**104:52: 312**
Specialization	**Automation & Robotics**	**Credits**	**24**
CIE Marks	**240**	**SEE Marks**	**160**

Rationale:

The growth of automation & robotics has been tremendously high in the recent years and the next few years are to witness great advancement in automation & robotic technology. In consequence, to the technology paradigm shift in the robotics field, Diploma courses in Robotics & Automation will become one of the top most career choices among the students. Robotics and Automation course focuses on the construction and operation, design automation of robotic devices, computer systems for necessary control action, feedback devices and information processing. Through project-based learning, design thinking, and inquiry learning, students will explore the technical skills needed to design and fabricate physical devices. Robotics and Automation is an interdisciplinary branch of Engineering that include Mechanical, Electrical, Electronics, Computer Science, Sensors and Instrumentation, Industrial Automation, Artificial Intelligence and Machine learning, Nanotechnology and Machine Vision. The course provides knowledge and exposure in the field of Automation and Robotics and other related areas of automated production systems.

Pre-requisite

Before the start of this specialization course, you will have prerequisite knowledge gained in the first two years on the following subjects:

1st year -Engineering Mathematics, Communication Skills, Computer Aided Engineering Graphics, Statistics & Analysis, Basic IT Skills, Fundamentals of Electrical and Electronics Engineering, Project Management skills, Digital Electronics

2nd year- Analog Electronics, Logic Design using Verilog, Communication Systems, Electronic Measurements and Testing Techniques, PCB Design & Fabrication, Wireless Communication, Embedded C Programming, Industrial Automation, in this year of study, you shall be applying your previous years learning along with specialized field of study into projects and real-world applications.

Instruction to course coordinator.

1. Each Specialized field of study is restricted to a Cohort of 20 students which could include students from other relevant programs.
2. One faculty from the Core Discipline shall be the Cohort Owner, who for teaching and learning in allied disciplines can work with faculty from other disciplines or industry experts.

3. The course shall be delivered in boot camp mode spanning over 12 weeks of study, weekly developmental assessments and culminating in a mini capstone.
4. The industry session shall be addressed by industry experts (in contact mode/online / recorded video mode) in the discipline only.
5. The cohort owner shall be responsible to identify experts from the relevant field and organize industry session as per schedule.
6. Cohort owner shall plan and accompany the cohort for industrial/mines/site/showroom/service Centre visits.
7. Cohort owner shall maintain and document the industrial assignments, weekly assessments, practices and mini project.
8. The cohort owner shall coordinate with faculties across programs needed for their course to ensure seamless delivery as per time table
9. The cohort owner along with classroom can augment or use for supplementally teaching on line courses available although reliable and good quality online platforms like Karnataka LMS, Infosys Springboard, NPTEL, Unacademy, SWAYAM etc.
10. Report should be maintained for industrial/field visit, such report shall be considered as industrial assignment.

Course outcomes: On successful completion of the course, the students will be able to,

CO1	**Demonstrate and Explain the Concept of Automation & Robotics, its components and applications in Industries.**
CO2	**Build and troubleshoot any automation system in a simulated or Real environment applying necessary Networking Protocols.**
CO3	**Install, troubleshoot and maintain PLC. Interface VFD with HMI and PLC to control motor parameters.**
CO4	**Test and troubleshoot Robotics system to meet defined operational specifications in a simulated or Real environment.**
CO5	**Implement the Robot operating System for various applications.**

Detailed course plan

Week	CO	PO	Days	1st session (9 am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
1	**Learning Outcomes**			**Introduction to Industrial Automation and Robotics.**							
	1	1,7	1	**Industrial** automation • Introduction to Automation. • Role & benefits of Automation in Industry. • Challenges faced by the manufacturing industry inManual Process. (Video documentary of any production industry)	2		2	• Present an Overview of Industry 4.0 and Challenges in implementation of Industry 4.0 in India • Importance of industrial automation in the Indian manufacturing industry • Compare and Contrast Leading Automation Component Manufacturers and their Market share.	1		2
			2	• Consider a use case to Demonstrate automation process involved in SMD of a PCB industry (Video demonstration) • Differentiate SMD and SMT	2		2	• Consider a use case to Demonstrate and analyse the following in Medical Electronics /equipment manufacturing Industry - Improving Manufacturing Plant Efficiency - Wastage of material - Adapting to Technological Change ✓ Present the role of Robotics for the above with an example.	2		1
			3	Types of automation in theindustry: ➢ Permanent / Fixed automation. ➢ Programmable/ Flexible automation. ✓ Demonstrate suitable automation for each	2		2	✓ Give a presentation on the role of Robotics in Packaging Industry /any suitable industry using ➢ permanent automation ➢ programmable automation	2		1

			4	Visit an Agarbhathi manual production Enterprise / Visit a paper plate production Enterprise/or any local manual production Enterprise			4	Submit a report on the manual production adopted and the effectiveness of the company if automation process is used in the Enterprise visited.		1	2
			5	**Developmental Assessment**				Assessment Review and corrective action			3
			6	**Industry Class** on Industry 4.0 Industry Assignment	2		2	Weekly Assignment(1PM-2PM)			1
2	**Learning Outcomes**			**Learn the Importance of Electronics in Automation Industry.**							
	1,2,3	1,3,6	1	Tutorial (Peer discussion on Industrial assignment)		4		• Case study: Video demonstration of Automatic potato chips production plant • Understand the importance of Electronics in automation of potato chips production plant ✓ Prepare and submit a report on the list of electronics components used in potato chip production plant and its specifications.	1		2
			2	**Variable Frequency Drive (VFD)** • Introduction • Building blocks of VFDs, • specifications, types and working principles.	2		2	• VFD with motor control panel • modules of VFD. • Industrial and domestic applications of VFDs.. ✓ Present a Case study on application of VFD drives for speed control in industry/ institute ✓ submit a report on the above	2		1
			3	Give a presentation on an industry application to INTEGRATE VFD WITH PLC			4	AC, DC, servo and stepper motors – Types , its industrial applications . ✓ Demonstrate all the above motors and their applications	2		1
			4	❖ Visit a near by automation industry and prepare a report on the specifications of VFD, motors, VFD Drives.			4	❖ Visit a near by automation industry and prepare a report on the specifications of VFD ,motors, VFD Drives.			3

			5	**Developmental Assessment**				Assessment Review and corrective action			3
			6	**Industry Class** on use of Electronics in Automation+ Industry Assignments	2		2	Weekly Assignment(1PM-2PM)			1
3	**Learning outcomes**			**Application of Sensors and Actuators in Automation and Robotics**							
	1,2	1,2,3	1	Tutorial (Peer discussion on Industrial assignment)		4		• Discuss the role of sensors in Automation & Robotics • List the selection of sensors in industrial automation system based on the given applications **Practise** Build a circuit for sensing any object using proximity sensor and indicating with LED	1		2
			2	❖ List and identify different types of sensors used in the automation industry visit ✓ Make a report on it with its specifications. **Practise** Build a circuit on proximity sensor/color sensor/sound sensor/temperature sensor(rtd type, capacitive type ,resistive type) and verify its working	1		3	Identify and List different types of sensors used in driverless car (artificial intelligence car). (video demonstration) ✓ Make a report on it with its specifications. ✓ Demonstrate resistive type sensor application using PLC	1		2

			3	• What is process Automation. • Demonstrate a case study on Process automation. ✓ List all the sensors and give its specifications for the above case study. **Practise** Build a circuit using Arduino on the above listed sensors for each given application and verify its working	2		2	• Demonstrate Automatic packaging Line for Lenovo Laptop. ✓ Prepare and submit a report on the components used for automation in the above industry, ✓ Identify and give a presentation on the role of Robots in the above automation process.	1		2
			4	**Actuators** • Introduction, its usage in Industrial Automation systems with real time application examples. • Contactors and Relays – concept, types, applications ✓ Demonstrate and explain the role of Actuators in - Automation packaging - Label scanning and printing, - Control solar panel direction, **Practice** Build a circuit to Control manually operated motor using contactor and Relay	2		2	• Industrial Robot actuators- Discuss Actuators based on type of motion and power used . ✓ Prepare a report on the usage of actuators for a given real time application in an pharmaceutical industry. ✓ Write a note on actuators vs Robots	1		2
			5	**CIE 1 – Written and Practice Test**				Assessment Review and corrective action			3
			6	Industry Class on sensors and actuators + Industry Assignment	2		2	Weekly Assignment(1PM-2PM)			1
4	**Learning Outcomes**			**Familiarization of PLC Installation Practices, troubleshooting and programming**							
	3	3,4,7	1	Tutorial (Peer discussion on Industrial assignment)		4		PLC Installation Practices, Editing, and Troubleshooting • PLC Enclosures, Electrical Noise, Leaky Inputs and Outputs , Grounding.	2		1

								• Voltage Variations and Surges Program Editing and Commissioning • Preventive Maintenance ✓ Troubleshoot the Processor Module, Input Malfunctions, Output Malfunctions of a PLC ✓ Prepare a report on the specifications of at least 8 manufacturers of PLC used in different industries			
			2	PLC Installation Practices, Editing, and Troubleshooting • Programming and Monitoring • PLC Programming software and their features ✓ Troubleshoot the Processor Module, Input Malfunctions, Output Malfunctions	2		2	Prepare, present and submit a report describing the installation, commissioning, and troubleshooting procedures of any production facility using PLC	1		2
			3	**PLC Programming** Classification and sub-classification of PLC programming languages. **Practise** Conduct the following using any one of Textual language and Graphical Form of PLC ➢ DOL starter and record its output ➢ Stair case light application ➢ Water level controller application	1		3	**Practise** ✓ VFD programming using PLC for switching the motor ON/OFF. ✓ VFD programming using PLC for variable motor SPEED.			3
			4	**Practise** Switch the Motor ON/OFF using contactor and Relay programmed by PLC	1		3	Analyse a Case Study on E - waste management using PLC . ✓ Prepare, present and submit a report describing a process to manage E – waste using PLC	1		2
			5	**Developmental Assessment**				Assessment Review and corrective action			3
			6	Industry Class-Industry Expert Talk / Lecture / Interaction on Modern PLC Controllers and its impact on Industry 4.0	2		2	Weekly Assignment (1PM – 2PM)			1

5	**Learning Outcomes**			**Implement Networking in Automation**							
	3	1,,3,7	1	Tutorial (Peer discussion on Industrial assignment)		4		**Network in Automation** ➢ Introduction to LANs ➢ Introduction to Serial Interfaces ➢ Common Industrial Buses ➢ Proprietary IO Buses **Practise** – perform networking experiment to provide wired and wireless(IP address and configuration) LAN connection	1		2
			2	**Network in Automation** ➢ Typical Network Architecture ➢ Network Cables & accessories ➢ Use of Fibre Optic Cables **Practise**- crimping practice of CAT5 cables	1		3	Video demonstration of firewall control over network access and restrictions **Practise**- Crimping of co – axial cables (RG6) and demonstrate its uses.	1		2
			3	Check for different pin configurations during the connection of RS 232 and RS 485 protocols. Practise **Practise** ✓ Use the above protocols for a given/specific application. ✓ optical fibre crimping /RS 232 /RS 485 protocol connections	1		3	INDUSTRIAL AUTOMATION PROTOCOLS Explain the importance of using the following protocols and Demonstrate any two of them . ➢ EtherNet/IP ➢ Profibus ➢ Modbus ➢ ProfiNet ➢ DeviceNet ✓ Prepare a report on different types of communication protocols and its uses.	1		2
			4	❖ Industrial Visit to food processing industry (automation, networking, robotics)/ any automation industry			4	❖ Prepare a report on the communication protocols used in food processing industry/any automation industry.		1	2
			5	**CIE 2 – Written and Practice Test**				Assessment Review and corrective action			3

			6	**Industry Class** on Networking in Automation	2		2	Weekly Assignment (1 PM-2PM)			1
6	**Learning Outcomes**			**Familiarise with automation simulation software & DCS/SCADA/HMI**							
	1,2,3	1,3,5	1	Tutorial (Peer discussion on Industrial assignment)		4		• Programmable Automation Controllers (PACs)-Role of PACs in modern industries. *Comparison between PLCs and PACs ✓ Prepare a report to Compare different brands of PLC hardware and software for a given application.	1		2
			2	Identify the suitable industry and explain the following PLC application . ➢ Controlling Geared DC motor with PLC. ➢ Controlling Stepper motor withPLC. ➢ Controlling Motor direction– Forward & Reverse. • Prepare and submit a report on the above. Also simulate the above using any simulation software.	1		3	• Implement/Simulate a Counter to count the object detected on theconveyor at the packaging department with any of below process and update onto PLC. ➢ Metal Detector Sensor withPLC ➢ Plastic Detector Sensor with PLC ➢ Distance measurement sensor integrating with PLC ➢ Color Detection sensor withPLC. ➢ Magnetic sensor with PLC **Note**: Trial version of SIEMEN PLANT Simulation Software(flow of material and logistics software) can be used	1		2
			3	Distributed Control System(DCS) ➢ Concept of DCS ➢ Data Acquisition ➢ Data Control ➢ Typical DCS Architecture ❖ PREPARE a report on the application of DCS/SCADA/HMI in a food processing industry/any automation industry.	1		3	Supervisory Control & Data Acquisition (SCADA) and HMI 1. Introduction to SCADA 2. Concept of Real time software 3. SCADA Architecture 4. Communication table for signal exchange 5. Introduction to communication protocols	1		2

				(from previous visit)				6. Creation of Database 7. Interfacing with PLC 8. Operating Screens 9. Application programming 10. Simulation / RUN time 11. Alarms, Trends & Bar graphs 12. Historical Data Management PREPARE a report on the application of DCS/SCADA/HMI in a food processing industry/ any automation industry. (from previous visit) **Practice** Interface SCADA, HMI integration in any automation industry using any simulation software.			
			4	Familiarize with the installation and tools of any simulation software used for automation.	2		2	Design, simulate and automate any application in automation industry with open-source software	1		2
			5	**Developmental Assessment**				Assessment Review and corrective action			3
			6	**Industry Class** on PLC applications and & DCS/SCADA/HMI	2		2	Weekly Assignment (1PM-2PM)			1
7	**Learning Outcomes.**			**Understand and Implement Arduino/PLC based Projects.**							
	1,2,3	2,3,4	1	Tutorial (Peer discussion on Industrial assignment)		4		• Overview of the Development of Arduino based projects using open-source simulation softwares. • Advantages of Arduino based projects • Differentiate Arduino controller and other microcontrollers ✓ Demonstrate a Case study on Comparison of Arduino with PLC	1		2

			2	A parking plot has a certain capacity of cars/two wheelers. Number of empty spots should be displayed on the display outside the Parking Plot and the spots available is to be indicated by LEDs ✓ Implement the above using Arduino board in your college premises			4	If Sump water level is minimum, send an alert to mobile and allow the inlet water. when the sump level is maximum, stop the inlet water. Switch on the motor if the overhead water tank is empty, only when the water in sump is sufficient. ✓ Implement the above in your college premises. **Note:** 1.Write a code in PLC simulator software 2. Turn water pump motor ON/OFF using PLC on Hardware. 3.Implement speed control of motor by using VFD			3
			3	Display the number of students in a classroom at any time of the day ✓ Implement the above using Arduino board in your classroom	1		3	The lights and fans should switch OFF if no one is present in the room. ✓ Implement it in your Labs/classrooms using Arduino	1		2
			4	To switch ON the street light during dark and automatically switch OFF during the Day time using Arduino ✓ Implement the above suitably in your college premises.	1		3	❖ Virtual tour on industries related to PLC applications in industries (ex. John distilleries, GTTC Centers)			3
			5	**CIE 3 – Written and Practice Test**				Assessment Review and corrective action			3
			6	**Industry Class** on development and simulation of Arduino projects	2		2	Weekly Assignment (1 PM-2PM)			1
8	**Learning Outcomes.**			**Introduction to Robotics**							
	1,4	1,3.7	1	Tutorial (Peer discussion on Industrial assignment)		4		CASE STUDY: Automatic Stamping Labelling Machine 1. Building a small Conveyor by interfacing the	1		2

								Geared DC motors and Free wheels. 2. Selection of Pneumatic valves to hold the labelling stamp 3. Interfacing Pneumatic linear actuator and Pneumatic Valve 4. Constructing the proper arrangements for Pneumatic valves, Pneumatic pipes, actuator and labelling stamp 5. Interfacing of Proximity sensor to PLC and testing by installing at the entry and exit position of conveyor 6. Interfacing the Indicators, 24vSwitches and Proper arrangement for power supply for wholeunit 7. Interfacing of 2 to 3 typesof Pneumatic actuators to get differentiate depend on the load and stroke length ✓ Identify the role of sensors, actuators and robot in the above case study and discuss its importance ✓ Demonstrate the actuator vs robot with reference to any other industrial application.			
			2	• Introduction to Robotics • Explain the need for Robotics in Automation industries • Types of robots. • Work Volume • Degree of Freedom- Forward and Back, Up and Down, Left and Right, Pitch, Yaw, Roll (video demonstration of different types of Robots)	2		2	Joint Notation & Type of joints in robot- Linear Joint (L Joint), Orthogonal Joint (O Joint), Rotational Joint (R Joint), Twisting Joint (T Joint), Revolving Joint (V Joint)	3		

			3	• Discuss the types of sensors used in industrial robot & their application • End Effectors- ➢ Grippers, Tools ➢ Types of grippers ➢ Factors to be considered for Selecting a Gripper (video demonstration of different types of sensors used in Robots)	2		2	• Introduction to Open Source Software- Robo Analyser Software/Robo studio/Gazebo. • Study the various tools in Robo Analyser Software /ROBO studio/Gazebo ✓ Simulate any simple activity using Robo Analyser Software/Robo studio/Gazebo			3
			4	Simulate any industry application of picking and placing an object from one place to another using Robo Analyser Software or any simulator	1		3	Simulate any industry application of picking and placing an object from one place to another using Robo Analyser Software or any simulator	1		2
			5	**Developmental Assessment**				Assessment Review and corrective action			3
			6	**Industry Class** on Robotic components + Industry Assignment	2		2	Weekly Assignment (1PM – 2PM)			1
9	**Learning Outcomes.**			**ROBOTIC CONTROL SYSTEMS**							
	4	1,3	1	Tutorial (Peer discussion on Industrial assignment)		4		Introduction and overview of robotic systems and their dynamics (Forward and inverse dynamics. Properties of the dynamic model and case studies. Introduction to nonlinear systems and control schemes) ✓ Prepare a report on the working dynamics for a given condition.	1		2
			2	Joint space and task space control schemes (Position control, velocity control, trajectory control and force control)	2		2	Discuss and make a report on use of Artificial Intelligence in robotics	1		2

				✓ Prepare a report on the working dynamics for a given condition.							
			3	Discuss the Applications in Unmanned systems, Defence, Medical and Industries. ✓ Prepare a report for usage of Robot in any of the above mentioned systems		1	3	Simulation of Basics of control: Open loop Closed loop Control P,PD,PI,PID Controllers using any simulation software. (Using MATLAB Trial version)			3
			4	Introduction to camera , Camera calibration, Vision Application in Robotics (automated navigation guidance by vision system) **Practice** Build a simple Line following ROBO using Arduino/Build a simple obstacle detection ROBO using Arduino	1		3	❖ visit to automation industries . (ex. GTTC center) ✓ Make a report on different types of ROBOTs used in automation industry			3
			5	**CIE 3 – Written and Practice Test**				Assessment Review and corrective action			3
			6	**Industry Class** on Robotic control systems	2		2	Weekly Assignment (1PM-2PM)			1
10	**Learning Outcomes**			**Robotics projects**							
	4	2,3,4	1	Tutorial (Peer discussion on Industrial assignment)		4		• Demonstrate a Case Study on Automated Guided Vehicle for Material Handling • Understanding the concept of AGV in different industrial sectors Example: Remote controlled AGV, Magnetic tape based AGV	1		2
			2	Demonstration of ROBOT WITH 2 DOF, 3 DOF Robot path planning using Robotic simulation software/Robo Analyser.			4	Demonstrate a Case study on MOBILE ROBOTICS ✓ prepare a report on use of MOBILE ROBOTICS in different industries.			3

			3	**Present a Robotic Coordinate system using arobot** • Joint co-ordinate system • Rectangular co-ordinate system • User or object coordinate system • Tool coordinate system. **Steps to define user co-ordinate system.** Defining X, Y, Z co-ordinate system Verifying co-ordinate system by multiple motion movements ✓ Simulate the above using ROBO Analyser software or any simulation software Refer the below links **https://www.youtube.com/watch?v=bAdqazixuRY** **https://www.youtube.com/watch?v=lv6op2HHIuM**	1		3	• Create a new model in Simulation Software- Robo Analyser Software or any simulation software. • Importing different types of robot • Identify the position variation in robots • Perform Robot axis movements			3
			4	**Perform Mechanical and Electrical Installation check of robot** • Checking of proper installation of the safety sensors • Checking of Physical grounding of robot and other peripheral devices (cable trays, fences,fixtures, electric boxes etc.). • Checking of the electric connections- Earthing cable,power cable, Pneumatic pipes etc ❖ Make a checklist and perform it on the industrial robot seen during the industrial visit.	1		3	**Do it Yourself** Build a TurtleBot personal Robot.			3

			5	**Developmental Assessment**				Assessment Review and corrective action				3
			6	**Industry Class** on simulation/Real time robotic projects	2		2	Weekly Assignment(1PM-2PM)				1
	Learning Outcomes			**Robot Programming**								
11	4	2,3,4, 7	1	Tutorial (Peer discussion on Industrial assignment)		4		Program a ROBO to trace a circular path using any simulation software				3
			2	Program a ROBO to trace a rectangular and square path using any simulation software			4	Program a ROBO to trace a elliptical path using any simulation software				3
			3	Program a ROBO to trace different Triangular path using any simulation software			4	Program a ROBO to trace a trapezoidal path using any simulation software				3
			4	Simulate a program to move a robot in a cubic and cuboidal shape.			4	Simulate a program to move a robot in a conical and cylindrical shape.				3
			5	**CIE 4 – Written and Practice Test**				Assessment Review and corrective action				3
			6	**Industry Class** on development and simulation of robotic programming + Industry Assignment	2		2	Weekly Assignment (1PM-2PM)				1
12	**Learning Outcomes.**			**Robot Operating System-ROS**								
	4,5	1,5,7	1	Tutorial (Peer discussion on Industrial assignment)		4		Introduction to ROS, Installation and Packages	2	1		
			2	ROS communication Tools (Topic, Services, Action)	2		2	Visualization and creation of custom environment with a robot	1			2
			3	Mapping of robot environment and navigation with mobile robot	1	1	2	ROBOT PATH Planning for AGV.	1			2
			4	Build a MAZE solving ROBOT in Real environment	1		3	Build a MAZE solving ROBOT in Real environment.	1			2

			5	**Developmental Assessment**				Assessment Review and corrective action			3
			6	**Industry Class** on Robot Operating System+ Industry Assignment	2		2	Weekly Assignment(1PM-2PM)			1
13											
				Internship **a) Secondary research on various industries and their operations to identify at least 3 companies along with the areas of work interest and develop an internship plan that clearly highlights expectations from the industry during the internship.** **b) Design and develop a cover letter for an internship request to all 3 identified companies and the resume to be submitted to potential companies.** **c) Prepare for an internship interview to highlight your interests, areas of study, career aspirations and personnel competence – including the areas of learning you expect to learn during internship**				***Project*** **a) Identification of the problem statement (from at least 3 known problems) the students would like to work as part of the project – either as provided by faculty or as identified by the student. Document the impact the project will have from a technical, social and business perspective.** **b) Design and develop the project solution or methodology to be used to solve at least one of the problems identified.** **c) Prepare a project plan that will include a schedule, WBS, Budget and known risks along with strategies to mitigate them to ensure the project achieves the desired outcome.**			40

References

Sl. No	Description
1	Automation, Production Systems, and Computer-Aided Manufacturing- Mikell P Grover, Prentice-Hall International publication.
2	Automating Manufacturing Systems with PLC by Hugh Jack.
3	Programmable logic Controllers by W. BOLTON.
4	Hand book of Modern Sensors" Physics, Designs and Applications- JACOB FRADEN-Springer Publications.
5	Springer Handbook of Automation by Shimon Y. Nof.
6	Robotics technology and flexible automation – S.R. DEB and S.DEB.
7	R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi, 4th Reprint, 2005.
8	John J.Craig, Introduction to Robotics Mechanics and Control, Third edition, Pearson Education.
9	M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill Singapore, 1996.
10	B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998
11	Automatic stamping Labelling machine using PLC -https://youtu.be/5QRKnYz4QP4
12	Color detection sensor using PLC - https://youtu.be/2Ax0bqZjkeU
13	https://rigbetellabs.com
14	http://NigelStanford.com/y/a-/Automatica
15	https://www.kuka.com/timo

CIE and SEE Assessment Methodologies

CIE Assessment	Assessment Mode	Duration In hours	Max Marks
Week 3	CIE 1– Written and practice test	4	30
Week 5	CIE 2– Written and practice test	4	30
Week 7	CIE 3– Written and practice test	4	30
Week 9	CIE 4– Written and practice test	4	30
Week 11	CIE 5– Written and practice test	4	30
	On line Course work (Minimum 10 hours online course with certification from (SWAYAM/NPTEL/Infosys Springboard)		40
	Profile building for Internship / Submission of Synopsys for project work		20
Portfolio evaluation (Based on industrial assignments and weekly developmental assessment) *			30
TOTAL CIE MARKS (A)			**240**
SEE 1 - Theory exam (QP from BTE) Conducted for 100 marks 3 hrs duration reduced to 60 marks		**3**	**60**
SEE 2 – Practical		**3**	**100**
TOTAL SEE MARKS (B)			**160**
TOTAL MARKS (A+B)			**400**

***The industrial assignment shall be based on peer-to-peer assessment for a total of 10 marks (on a scale of 1 to 10) and in the event of a group assignment the marks awarded will be the same for the entire group, the developmental assessment will be for a total of 20 marks and based on MCQ/case study/demonstration and such other assignment methods.

Assessment framework for CIE (1 to 5)

Note: Theory to be conducted for 1 hour and practice for 3 hours, total duration of exam – 4hrs

Programme	**Electronics & Communication Engineering**	**Semester**	**V**
Course	**Automation & Robotics**	**Max Marks**	**30**
Course Code	**20EC53I**	**Duration**	**4 hours**
Name of the course coordinator			

Note: Answer one full question from each section.

Qn.No	**Question**	**CL L3/L4**	**CO**	**PO**	**Marks**
	Section-1 (Theory) – 10 marks				
1.a)	For a given application implement the following condition in PLC environment to automate the process . i) A LOW is generated from the output of the system when BCD is present BCD →0 ii) A HIGH is generated from the output of the system when BCD is not there Non BCD →1	L3/L4	CO1,CO2	1,7	5
b)	with an example explain how VFD drives are interfaced with PLC for motor speed control in industry	L3	CO3	1,3,6	5
2.a)	Identify and list the sensors used in conveyor belt in a specified automation industry	L4	CO1,CO2	1,7	5
b)	Demonstrate how the conveyor belt movement and speed is controlled .	L4	CO3	1,3,6	5
	Section-2 (Practical) - 20 marks				
3)	In a given orange juice the pH value is ideally observed to be 5.7 . But the juice is monitored to be 6.7 which makes it in-edible. Automate the system , so that a neutral solution is added for the juice whenever it is changed its concentration wrt its ideal value. simulate using any simulation software	L3/L4	CO1,CO2	1,2,3,7	20
4)	Implement a PLC environment for a water level controller automation from sump to tank	L3/L4	CO1,,CO2	1,2,3,7	20

Note : Theory questions shall be aligned to practical questions

Assessment framework for SEE 1 (Theory)

Programme : Electronics & Communication Engineering
Semester : V.
Course : Automation & Robotics **Max Marks: 100**
Course Code : 20EC53I **Duration: 3 Hrs**

Instruction to the Candidate: Answer one full question from each section.

Q.No	Question	CL	CO	Marks
	Section-1			
1.a)	Consider a beverage industry and illustrate the role of inventory management to sustain continuous production.	L4	1	10
b)	Analyse the role of Industry 4.0 in enhancing the existing production methodology through automation. Illustrate with an example.	L3		10
2.a)	How would you filter out damaged or rotten fruits as well as unwanted debris during the intial cleaning process in a beverage industry	L4		10
b)	Illustrate the role of sensor to check the quantity of beverage filled in a bottle.	L3		10
	Section-2			
3.a)	How would you choose to change the filling of kissan Jam from Glass containers to sachet on the same production lines. Explain the role of VFD in the production line	L4	3	10
b)	Mention the requirement of PLC in the above automation	L3		10
4.a)	Consider a plant, manufacturing tyres using a permanent automation structure.Is it possible to make the manufacturing through programmed automation at any stage of the manufacturing process. Justify your answer.	L4		10
b)	Describing the installation, commissioning, and troubleshooting procedures facility in paint manufacturing industry using PLC	L3		10
	Section- 3			
5.a)	How would you Test and Analyse the functionality of Dam shutter control system to meet exact operational specifications . Explain the Networking protocols used.	L4	2	10
b)	Test and Analyse the PLC based Airport baggage system considering 4 different locations.	L4		10

6.a)	Consider elevator in a 10-storey building, write the troubleshoot results for smart elevator controlling system by considering all the possible outcomes of a elevator. Analyse the Networking in its Automation.	L3		10
b)	Consider the case of a PLC based automatic robotic Car washing system and report the test results.	L3		10
Section-4				
7.a)	Analyse and report the test results for 5 axis robotic arm controlled by touchscreen display.	L4	4	10
b)	Troubleshoot and write the analysis report for operation of line follower robot in textile industry.	L4		10
8.a)	Consider biscuit manufacturing company, report the test results by considering the case of robots used in final inspection and packaging section in biscuit manufacturing.	L4		10
b)	Considering the application of robotic gesture control system for gaming company, analyse and list out the results.	L3		10
Section-5				
9.a)	Why we need ROS for the development of Robots, give some examples.	L4	5	10
b)	How to develop simple self balancing robot system	L3		10
10.a)	How to test the functionality and specific parameters of an 3 axis robotic hand build using ROS.	L4		10
b)	Give the application of ROS over microcontroller program.	L3		10

Scheme of Evaluation for SEE 2

Sl. No	Description	Marks
	1. Design and develop any sensor based smart PLC application in simulated or real environment. OR 2. Design and develop any PLC/Arduino based robotic automated system in simulated or real environment.	
1	Writing the program/ Design	20
2	Building the circuit/ simulation	20
3	Conduction of the experiment/project	20
4	Troubleshoot/Result	20

5	Viva voce	20
Total		**100**

Equipment / Software List with specification for a batch of 20 students.

Sl No	Equipment's	Specification	Quantity
1	PLC Systems with digital I/P, O/P modules and software	12/24v Dc/relay 6 Digital Inputs , 4 Digital Outputs, ethernet card standard micro Sd card integrated webserver	2
2	HMI / HMI DEMOBOARDS with software	7 inch panel, 24 V DC	2
3	PLC control panel	With mounting arrangement for PLC power supply pushbutton switch etc.	2
4	1) PLC kit with suitable software 2) Arduino uno kits & Arduino IDE software 3) voltage current sound dust sensors 4) pick and place robot with external arm set 5) Relevant sensors for various experiments	as per industry standards.	1
5	Variable frequency drive (VFD)	2 HP	2
6	Arduino/Raspberry Pi board		5

E- Mobility

Government of Karnataka

DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Program	**Electronics & Communication Engineering**	**Semester**	**5**
Course Code	**20EC54I**	**Type of Course L:T:P**	**104 : 52 : 312**
Specialization	**E- Mobility**	**Credits**	**24**
CIE Marks	**240**	**SEE Marks**	**160**

Rationale:

Welcome to the curriculum for the Specialization Pathway E-Mobility. This specialization course is taught in Boot camp mode. Boot camps are 12 weeks, intense learning sessions designed to prepare you for the practical world – ready for either industry or becoming an entrepreneur. You will be assisted through the course, with development-based assessments to enable progressive learning. In this course, you'll learn how to develop and exploit Electric Vehicle system in a range of manufacturing and EV applications that are needed for today's job market.

Leading to the successful completion of this boot camp, you shall be equipped to either do an internship in an organization working on E-Mobility or do a capstone project in the related field. After the completion of your Diploma, you shall be ready to take up roles like a Programmer, Supervisor and can rise up to the level of Manager, also can become Entrepreneur in the related field and more

This course will teach you about E-Mobility, Energy storage system, Battery Management System (BMS), EV System Design, EMC/EMT testing, Electric Drive and Power Train, Sensors used in EVs, IOT applications in Electric Vehicles and more. Details of the curriculum is presented in the sections below.

Pre-requisite

Before the start of this specialization course, you will have prerequisite knowledge gained in the first two years on the following subjects:

1st year -Engineering Mathematics, Communication Skills, Computer Aided Engineering Graphics, Statistics & Analysis, Basic IT Skills, Fundamentals of Electrical and Electronics Engineering, Project Management skills, Digital Electronics

2nd year- Analog Electronics, Logic Design using Verilog, Communication Systems, Electronic Measurements and Testing Techniques, PCB Design & Fabrication, Wireless Communication, Embedded C Programming, Industrial Automation, in this year of study, you shall be applying your previous years learning along with specialized field of study into projects and real-world applications.

Instruction to course coordinator.

1. Each Specialized field of study is restricted to a Cohort of 20 students which could include students from other relevant programs.
2. One faculty from the Core Discipline shall be the Cohort Owner, who for teaching and learning in allied disciplines can work with faculty from other disciplines or industry experts.
3. The course shall be delivered in boot camp mode spanning over 12 weeks of study, weekly developmental assessments and culminating in a mini capstone.
4. The industry session shall be addressed by industry experts (in contact mode/online / recorded video mode) in the discipline only.
5. The cohort owner shall be responsible to identify experts from the relevant field and organize industry session as per schedule.
6. Cohort owner shall plan and accompany the cohort for industrial/mines/site/showroom/service Centre visits.
7. Cohort owner shall maintain and document the industrial assignments, weekly assessments, practices and mini project.
8. The cohort owner shall coordinate with faculties across programs needed for their course to ensure seamless delivery as per time table
9. The cohort owner along with classroom can augment or use for supplementally teaching on line courses available although reliable and good quality online platforms like Karnataka LMS, Infosys Springboard, NPTEL, Unacademy, SWAYAM etc.
10. Report should be maintained for industrial/field visit, such report shall be considered as industrial assignment.

Course outcomes: On successful completion of the course, the students will be able to,

CO1	**Identify the type of E- vehicles, components, architecture and its applications.**
CO2	**Analyse the EV - government policies, automobile regulatory bodies functionalities, vehicle dynamics, transmission system.**
CO3	**Demonstrate the working of electric motor drives, sensors and the role of power electronics in EV's.**
CO4	**Analyse the communication protocols, battery management systems, charging systems and demonstrate them.**
CO5	**Model, test & troubleshoot the motors, battery packs, electric vehicle & analyze its performance parameters using the simulation software.**

Detailed course plan

Week	C O	P O	Days	1st session (9 am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
1	**Learning Outcomes**			**1. Introduction to E-mobility.** **2. Government policies related to EV.** **3. Exposure to the automobile regulatory bodies.**							
	1,2	1	1	<< Video Demonstration of E- Mobility>> https://youtu.be/tJfERzrG-D8 E – Mobility – Introduction, Benefits & Future Technologies. Comparison between Internal Combustion Engines (ICE) vehicles & E-Vehicles (EV).	2		2	EV's - Costs and Emissions: Electricity costs, End of Life, CO2 Emissions. Types of different pollutants produced due to IC engine vehicle (ICEV) and their effect on human health. Economic and environmental impacts of using E – Vehicles.	1		2
			2	Electric Vehicle – Overview (TATA, Maruthi Suzuki, KIA, TESLA, HYUNDAI, etc), Types, Indian Market Scenario. EV Terminologies & EV Manufacturers.	1		3	EV parameters: weight, size, force, energy & performance parameters. Autonomous cars: Introduction, Google Self driving car, Hacking.	1		2
			3	Polices in India – Incentives, PLI (Production Linked Incentive) scheme, battery swapping policy, special E-Mobility zone. Need for regulation, Regulations for EV in India.	1	1	2	Government Policies related to Energy, EV Subsidies and their role in EV adoption.	1		2
			4	Automobile regulatory bodies & Societies like ARAI, SAE, CMVR, etc – standards, functions and its importance.	2		2	E – Mobility: Myths, Success Factors & Challenges. The Future of Sustainable Transportation.	1		2
			5	Developmental Assessment				Assessment Review and corrective action			3
			6	**Industry class -** E- Mobility	2		2	Weekly Assignment(1PM-2PM)			1

2	**Learning Outcomes**			**1. Explain the different aspects of Vehicle Dynamics.** **2. Identify the components of Transmission system: gear train and power train.** **3. understand the concepts of regenerative braking, develop simulation models.**							
	1,2	1,4	1	Tutorial (Peer discussion on Industrial assignment)		4		Vehicle Dynamics - Introduction. Types of Vehicle Resistance – Rolling resistance, Grading resistance & Aerodynamic drag. **Practise** Develop a simulation model to analyse the effect of rolling resistance on vehicle range and performance.	1		2
			2	• Calculating the rolling resistance • Calculating the grade resistance • Calculate the Aerodynamic drag • Calculating the Acceleration Force • Calculate the maximum speed of vehicle **Practise** Develop a simulation model to analyse the effect of Aerodynamic drag on vehicle range and performance.	1		3	Transmission System. Introduction to Gear Train & Power train in EV. Explain and Demonstrate the Working principle and components of Gear Trains used in EV.	1		2
			3	EV Power train – Components, Block diagram & it's working principles. Demonstration of its integration. **Practise** Develop a simulation model to analyse the effect of vehicle Mass on vehicle range and performance.	1	1	2	Brakes for EVs: Types. Regenerative Braking – concept, working principle, advantages. **Practise** Develop a simulation model to analyse Electric motor Regenerative braking characteristics for different driving cycles.	1		2

			4	Electronic power assisted steering - Concept, components, working principle, demonstration. power windows - Concept, components, working principle, demonstration.	1		3	Tyre selection factors for EV. Demonstration & comparison of steel wheels & alloy wheels. Demonstration & comparison of tube & tubeless tyres.	1		2
			5	**Developmental Assessment**				Virtual tour on Electric and Hybrid vehicle			3
			6	**Industry Class** on vehicle dynamics.	2		2	Weekly Assignment(1PM-2PM)			1
3	**Learning outcomes**			**1. identify the configurations of battery electric vehicles.** **2. Understand the different components, working principle, performance parameters of electric vehicles.**							
	1,2,3	1,3	1	Tutorial (Peer discussion on Industrial assignment)		4		Configuration of Electric Vehicles, vehicle performance. Concept of Hybrid Electric Drive Trains.	1		2
			2	Battery Electric Vehicles (BEV) – concept, architecture, major components, working principle, performance parameters, merits and demerits with demonstration.	1		3	Hybrid-Electric Vehicles (HEV) - concept, architecture (series drive train, parallel drive train), major components, working principle, performance parameters, merits and demerits with demonstration.	1		2
			3	Plug-in hybrid vehicles (PHEV) - concept, architecture, major components, working principle, performance parameters, merits and demerits with demonstration.	1		3	Fuel cell electric vehicles (FCEV) - concept, architecture, major components, working principle, performance parameters, merits and demerit with demonstration.	1		2
			4	Compare the features of BEV, HEV, PHEV, FCEV type of vehicles Discuss on current adoption status of BEV, HEV, PHEV, FCEV type vehicles.	2		2	four-wheel drive system- concept, block diagram, benefits. Demonstration.	1		2
			5	**CIE 1 – Written and Practice Test**				Assessment Review and corrective action			3
			6	**Industry Class** on Electric & Hybrid electric Vehicles	2		2	Weekly Assignment (1PM-2PM)			1

4	**Learning Outcomes**			**1. Identify the various sensors and control systems in EV.** **2. Identification of power electronics components & their role in EV.** **3. Importance of Electronic stability control in vehicles.**								
	1,3	2,4	1	Tutorial (Peer discussion on Industrial assignment)		4		Role of sensors in electric motor systems used in EV.	1		2
			2	Importance of Power electronics in E -Vehicles - switched mode power converters, DC-DC Converters, Rectifiers & Inverters, switch controller, Solid State controllers, electronic controllers – working principle & applications. Battery Monitoring Sensors, State of the Charge Sensing, MEMS Sensors for Engine Management, Hall effect sensors.	1		3	Switching devices– diodes/IGBT's/MOSFETs, Onboard chargers/offboard chargers – working principle & applications. Sensors for Passenger Safety, Sensors for Skidding and Rollover Detection, Tire Pressure Sensors.	1		2
			3	Electronic Stability Control of Vehicles – components, demonstration. Sensors for Antitheft, Vehicle Navigation Sensors. EV sensors of Texas Instruments, STM, NXP, etc.	1		3	Traction control, Body and chassis control, Onboard/Offboard charger control, Battery Management system control, Auxiliary power system and its control.	1		2
			4	Examples of control with MATLAB/open-source Simulink Control Toolbox with explanation.	1		3	Virtual tour on sensors and controls in electric vehicles	1		2
			5	**Developmental Assessment – Poster Presentation of Battery basics and Types**				Assessment Review and corrective action			3
			6	**Industry Class** on sensors & control systems in EV.	2		2	Weekly Assignment (1PM – 2PM)			1
5	**Learning Outcomes**			1. **Exposure to the various communication protocols, architecture & applications.** 2. **Using the CANalyser/CANoe software for intuitive operation for analysis and stimulation of network communication.** 3. **Advanced Driver Assistance System (ADAS) – components and features.**								
	4	2,3,4	1	Tutorial (Peer discussion on Industrial assignment)		4		Communication Protocols – Need for protocols. Local Interconnect Network (LIN) – Concept, Architecture, Applications & Demonstration.	1		2

			2	Control Area Network (CAN) Protocol– concept, layered architecture, applications & demonstration. FlexRay Protocol - concept, layered architecture, applications & demonstration.	1		3	Demonstration of CANalyser/CANoe software (CAN related software), application areas – analysis, diagnostics, logging, etc.	1		2
			3	Media Oriented Systems Transport (MOST) protocol- Concept, architecture, applications & demonstration. Similarities and differences of LIN, CAN, FlexRay Protocols. AUTOSAR – concept, architecture & features.	1	1	2	Advanced Driver Assistance System (ADAS) – Concept, Architecture & Features. components - Image processing cameras, RADAR (Radio detection & ranging), LIDAR (Light detection & ranging), Ultrasonic sensors, Electromagnetic sensor. adaptive cruise control, etc.	1		2
			4	Role of an ECU, ECU software, types of MCUs: NXP, TI, Infineon – features. STM32 Microcontroller – features, programming, applications.	2		2	Demonstration of STM32CUBE IDE software with simple application programs.			3
			5	**CIE 2 – Written and Practice Test**				Assessment Review and corrective action			3
			6	**Industry Class** on communication protocols.	2		2	Weekly Assignment (1 PM-2PM)			1
6	**Learning Outcomes**			**1. Implementation of Electric drive systems & Power Trains.** **2. BLDC motor control using Pulse width modulation. (PWM).** 3. **Simple problems to calculate speed, torque, power consumption.**							
	3	3,4	1	Tutorial (Peer discussion on Industrial assignment)		4		**Fundamentals:** General architecture and requirement of EV, load characteristics.	1		2
			2	principle of electromechanical energy conversion. motors and generator – concept, working principle, demonstration. Factors to be considered for selection of motor Types of Electric Drives: DC motors & BLDC motors – concept, components, working principle, demonstration.	1		3	BLDC motor control using Pulse width modulation. (PWM). **Practise Activity**: Perform speed control of BLDC Motors.	1		2

			3	**Practise** Modelling and simulation of BLDC motor using a open source simulation software.			4	Permanent Magnet Synchronous Motor (PMSM) - concept, components, working principle, demonstration. Switched Reluctance Motors (SRM) – concept, components, working principle, demonstration.	1		2
			4	Induction motors - concept, components, working principle, demonstration. power electronics-based control of electric motors – control strategies: types – direct torque control (DTC), Field oriented control (FOC).	2		2	Calculate speed and torque of motor Calculate Power consumption of EV Selection and sizing of Motor, Example problems.	1		2
			5	**Developmental Assessment**				Assessment Review and corrective action			3
			6	**Industry Class** on electric drives and power trains	2		2	Weekly Assignment (1PM-2PM)			1
7	**Learning Outcomes.**			**1. requirement of Energy Storage Systems & Batteries.** **2. battery terminologies & specification parameters.** **3. different types of batteries & its operations.**							
	4	1,2,3	1	Tutorial (Peer discussion on Industrial assignment)		4		**Fundamental:** Energy storage requirements for vehicle applications, types of energy resources, sources of energy, Storage technologies and metrics for comparison, Energy generation, supply, distribution. Introduction to battery cell, battery module, battery pack.	1		2
			2	Energy devices & combinations, Duty Cycles in Indian cities; performance, Sustainability assessment.	1		3	Theory of Ragone Plots. Ragone Plot of a Battery – example. Lead Acid Battery (PbA) – Construction,	1		2

				Battery terminologies: power density, battery efficiency, discharge rate, State of Charge (SOC), State of Health (SOH), State of Energy (SOE) State of Power (SOP), state of discharge (SOD) Depth of discharge (DOD), C -Rate, drive cycle. Battery specifications: Energy density, Specific Energy, Charge Temperature Interval, Charge/discharge inefficiency, cycle durability, Nominal cell voltage. Batteries: Range, Battery Life & Recycling, Types. Basic of Battery – How it is made and concept of batteries, Storage types.				working principles, advantages. Nickel Metal hydride (Ni-MH) battery- Construction, working principles, advantages. Explain the battery specifications of the any 2 Indian EV's. **Practise** Measure normal open circuit voltage charging voltage & current of a battery used in any vehicle.			
			3	Nickel- cadmium (Ni-Cad) battery – construction, working principles, advantages. Lithium- ion (Li-ion) Battery – construction, working principle, advantages. **Practise** Verify Ampere- hour capacity of a battery with any available load.	1	1	2	Sodium–Sulfur (Na–S) Battery - construction & working principle, advantages. Fuel Cells – construction, operation & advantages. Supercapacitors, Flywheels – features & operation.	1		2
			4	Explain Cell Charging and Discharging cycles and Discharging Curves. Calculations on Battery charging and discharging. Explain the Temperature impact on cell, Internal resistance. Video demo on fabrication and process of battery.	2		2	Evolution of batteries. Power Density and Energy Density concepts with basic calculations and examples.	1		2

			5	**CIE 3 – Written and Practice Test**				Assessment Review and corrective action			3
			6	**Industry Class** on energy storage systems and batteries.	2		2	Weekly Assignment (1 PM-2PM)			1
8	**Learning Outcomes.**			**1. Importance of Battery management systems & its functionalities.** **2. Battery pack configurations & factors affecting battery performance.** 3. **Modelling of electric vehicle batteries and battery pack by using simulation software.**							
	2,4,5	1,3,7	1	Tutorial (Peer discussion on Industrial assignment)		4		Battery Management system- components, block diagram, functionalities, importance, benefits. Explain battery management design considerations (Service life, efficiency, safety, operational parameters, etc.).	1		2
			2	Battery Pack Module: Types, procedure, Configurations, demonstration. Criteria for battery selection pack, Cost reduction of the overall battery pack for EV. **Practise** Design a battery pack rated capacity 25Ah in a simulation software with C rate calculation.	1		3	Battery working temperature – temperature list for all type of batteries**.** Different types of electrolytes and additives used in batteries. Factors affecting Battery Performance- electrolyte used, chemical reaction, packing of cell, high current ratings, safety, cost, aging, etc. Causes of battery explosion	1		2
			3	Modelling of Electric vehicle batteries and battery pack by using simulation software	1	1	2	Modelling of Electric vehicle batteries and battery pack by using simulation software	1		2
			4	Modelling of Electric vehicle batteries and battery pack by using simulation software	2		2	Modelling of Electric vehicle batteries and battery pack by using simulation software	1		2
			5	**Developmental Assessment**				Assessment Review and corrective action			3

			6	**Industry Class** on battery management systems	2		2	Weekly Assignment (1PM – 2PM			1
9	**Learning Outcomes.**			**1. Fabrication of batteries and battery testing methods.** **2. Importance of thermal management systems & cooling operations.** 3. **Process EV charging, components & charging station.**							
	4	1,3,7	1	Tutorial (Peer discussion on Industrial assignment).		4		Gas formation inside the battery – Reason and Solution to avoid gas formation - concept, demonstration, working principle. High current rate performance along with Stability and Recycling Importance and process.	1		2
			2	Fabrication of battery which is completely non-flammable – concept, demonstration, working principle, advantages.	1		3	Battery testing- methods, disposal and secondary use of batteries. Demonstrate the car battery testing procedure.	1		2
			3	Thermal runaway. EV Thermal Management Systems (TMS) - Need, significance. Explain Cooling of Battery Pack, Motor and Inverter, types, advantages. Explain Active and Passive Cooling. Demonstration of Thermal Management systems and it use in system level algorithms and communications.	1	1	2	EV Charger: components, types, block diagram, charging methods, charging standards.	1		2

			4	Design rating & difference between slow charger and fast charger. Charging plugs – Types with specifications. vehicle to grid technology(V2G), grid to vehicle technology(G2V), vehicle to building(V2B), vehicle to home (V2H), smart charging- concept, applications. Tesla Powerwall – concept & applications.	2		2	Wireless power transfer. EV Charging station – components, block diagram. How to make EV charging sustainable? Demonstration.	1		2
			5	**CIE 4 – Written and Practice Test**				Assessment Review and corrective action			3
			6	**Industry Class** on thermal management systems.	2		2	Weekly Assignment (1PM-2PM)			1
10	**Learning Outcomes**			**1. Types of charging protocols.** **2. Case studies.** 3. **Hazard management & on-board diagnostics (OBD).**							
	4	1,5,7	1	Tutorial (Peer discussion on Industrial assignment)		4		Charging protocols: Open Charge Point Protocol (OCPP), Open Smart Charging Protocol (OSCP), Demonstration.	1		2
			2	Charging protocols: Open Charge Point Interface (OCPI), ISO 15118 – concept & features. Roadmap for EV testing & validation, testing & validation standards.	1		3	Vehicle Navigation Based on MEMS-types of navigation system, MEMS vehicle positioning method. Demonstration.	1		2
			3	Electric vehicle charging systems demo video/hands on. Demonstration with explanation.	1	1	2	Electrification challenges. Diagnosis and remedy	1		2

				Demonstrate Communication Interface between charger and CMS (central management system) Demonstrate communication between charger and EV.				a) for charger not responding, b) charger not delivering expected current.				
			4	Fire in EV 's - possible causes & solution – case study. (Any two) Risks of working with EV's. Protection devices against high voltages.	1		3	On –board diagnostics (OBD) – concept, usage, demonstration. List the tools and Equipment's for safety & hazard management of EV's.	1		2
			5	**Developmental Assessment**				Assessment Review and corrective action			3
			6	**Industry Class** on hazard management & diagnostics	2		2	Weekly Assignment(1PM-2PM)			1
	Learning Outcomes			**1. EMC/EMT testing standards of electric vehicles.** **2. Electronic instrumentation cluster options and messages.** **3. Troubleshooting with Measuring equipment's.**							
11	5	1,3,4,5,7	1	Tutorial (Peer discussion on Industrial assignment)		4		EMC/EMT testing standards of electric vehicles, ISO 26262 Functional safety standards In-Vehicle Communication Challenges.	1		2
			2	Explain & demonstrate the electronic instrumentation cluster for battery status, distance to empty, battery temperature, gear position indicator, tyre air pressures, cabin temperature, vehicle speed, trip information, Warning and indicator lights, display messages, GPS, fault diagnosis, fuel information, etc – features, warning signals, actions to be taken when the respective	2		2	Battery cell balancing and other Electronics circuits design in an EV.	2		1

				lights are blinking.								
			3	**EV authorized service station – visit**, to learn about the practical aspects like, ➢ Procedure followed in the service station, from entry to exit. ➢ Historical Data analysis of E-vehicles. ➢ Safety tools & practices that are followed. ➢ Common faced issues and their solutions. ➢ Importance of predictive maintenance and following the maintenance schedules. ➢ On – Board Diagnostic (OBD) generally used and their inferences. ➢ Better efficient type of E- vehicle. ➢ Location of the battery and its assembly connections. Prepare a detailed report. & demonstrate in the class.							7
			4	Measuring Equipment's: Power analyser, digital storage oscilloscope (DSO)– working principle, applications. Demonstrate/perform the testing of power electronic devices / inverters/motors drives/lighting/home appliances/power supplies/industrial machineries using power analyser & DSO.	1	1	2	Management of EV systems – general safety precautions., Vehicle modelling/Simulation tools (SIMPLEV, MARVEL V-Elph, Others: PSAT, CarSim, OSUHEVSim, Hybrid Vehicle Evaluation code (HVEC) – explore any 2 simulation tools for simulation purpose.	1		2
			5	CIE 5– Written and Practice Test				Assessment Review and corrective action				3
			6	**Industry Class** on testing standards.	2		2	Weekly Assignment (1PM-2PM)				1
12	**Learning Outcomes.**			**Performing Vehicle integration using simulation software.**								
	5	2,3,6,7	1	Tutorial (Peer discussion on Industrial assignment)		4		Modelling of E – vehicle using simulation software.				3

			2	Model the Electric Vehicle Integration by using simulation software and analyze the EV performance parameters such as speed, Torque, Top speed reached, distance traveled, SOC, regenerative braking effort, current, voltage for different drive cycles, electric drives & power rating, and also analyze the impact of vehicle dynamics like rolling resistance, air drag, frontal area, weight of the body etc on EV performance.							7
			3	Model the Electric Vehicle Integration by using simulation software and analyze the EV performance parameters such as speed, Torque, Top speed reached, distance traveled, SOC, regenerative braking effort, current, voltage for different drive cycles, electric drives & power rating, and also analyze the impact of vehicle dynamics like rolling resistance, air drag, frontal area, weight of the body etc on EV performance.							7
			4	Model the Electric Vehicle Integration by using simulation software and analyze the EV performance parameters such as speed, Torque, Top speed reached, distance traveled, SOC, regenerative braking effort, current, voltage for different drive cycles, electric drives & power rating, and also analyze the impact of vehicle dynamics like rolling resistance, air drag, frontal area, weight of the body etc on EV performance.							7
			5	**Developmental Assessment**				Assessment Review and corrective action			3
			6	**Industry Class** on modelling of EV integration and analysis of performance parameters.			4	Weekly Assignment(1PM-2PM)			1
13				***Internship*** **a) Secondary research on various industries and their operations to identify at least 3 companies along with the areas of work interest and develop an internship plan that clearly highlights expectations from the industry during the internship.** **b) Design and develop a cover letter for an internship request to all 3 identified companies and the resume to be submitted to potential companies.** **c)Prepare for an internship interview to highlight your interests, areas of study, career aspirations and personnel competence – including the areas of learning you expect to learn during internship**				***Project*** **a) Identification of the problem statement (from at least 3 known problems) the students would like to work as part of the project – either as provided by faculty or as identified by the student. Document the impact the project will have from a technical, social and business perspective.** **b) Design and develop the project solution or methodology to be used to solve at least one of the problems identified.** **c)Prepare a project plan that will include a schedule, WBS, Budget and known risks along with strategies to mitigate them to ensure the project achieves the desired outcome**			40

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Sl. No	Description
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2	Electric and Hybrid Vehicles by Tom Denton. (Institute of the Motor Industry)
3	Electric power train: Energy Systems ,Power Electronics and Drives for Hybrid, Electric and fuel cell vehicles by John G Hayes , G Abas Goodarzi, Wiley Publications.
4	Modern electric, hybrid electric, and fuel cell vehicles: fundamentals, theory, and design, by Sebastian, Yimin Gao , CRC Press publications.
5	Advanced Electric Drive Vehicles by Ali Emadi , CRC Press publications.
6	Lithium Batteries:: Research, Technology and Applications by Greger R. Dahlin , Nova Science publishers.
7	Fundamentals and Application of Lithium-ion Batteries in Electric Drive Vehicles by Jiuchun Jiang & Caiping Zhang , Wiley Publications.
8	S. Dhameja, “Electric Vehicle Battery Systems, Newnes”, 1st edition, 2001.
9	W. Liu, “Hybrid Electric Vehicle System Modeling and Control”, 2nd edition, Willey, 2017
10	K. T. Chau, “Energy Systems for Electric and Hybrid Vehicles”, The Institution of Engineering and Technology, 2016
11	B. Scrosati, J. Garche and W. Tillmetz, “Advances in Battery Technologies for Electric Vehicle”, Woodhead, 1st edition, 2015.
12	V. Pop, H.J. Bergveld, D. Danilov, P.P.L. Regtien, P.H.L Notten, “Battery management systems: Accurate state-of-charge indication for battery-powered applications” Springer Science & Business Media, Vol. 9. 2008.
13	https://youtu.be/ih0UyVc6sJA Electric Vehicle Simulation in Simulink | MATLAB Helper Blog
14	https://youtu.be/5ZTQE-ptxYM Modelling an Electric Vehicle using MATLAB & Simulink (Part - 1)
15	https://youtu.be/oVk9180a8Qs Modelling an Electric Vehicle using MATLAB & Simulink (Part - 2)
16	https://youtu.be/ugnRnVBs_BI Modelling an Electric Vehicle using MATLAB & Simulink (Part - 3)
17	https://youtu.be/eQX-iobIYmw Modeling Batteries Using Simulink and Simscape
18	https://youtu.be/d7L_gv344lc How to design battery pack in MATLAB Simulink With C Rate Calculation
19	https://youtu.be/rCstGDb4R3M Design BLDC Motor Speed Controller in Simulink

CIE and SEE Assessment Methodologies

CIE Assessment	Assessment Mode	Duration In hours	Max Marks
Week 3	CIE 1– Written and practice test	4	30
Week 5	CIE 2– Written and practice test	4	30
Week 7	CIE 3– Written and practice test	4	30
Week 9	CIE 4– Written and practice test	4	30
Week 11	CIE 5– Written and practice test	4	30
	On line Course work (Minimum 10 hours online course with certification from (SWAYAM/NPTEL/Infosys Springboard)		40
	Profile building for Internship / Submission of Synopsys for project work		20
Portfolio evaluation (Based on industrial assignments and weekly developmental assessment) *			30
TOTAL CIE MARKS (A)			**240**
SEE 1 - Theory exam (QP from BTE) Conducted for 100 marks 3 hrs duration reduced to 60 marks		**3**	**60**
SEE 2 – Practical		**3**	**100**
TOTAL SEE MARKS (B)			**160**
TOTAL MARKS (A+B)			**400**

***** The industrial assignment shall be based on peer-to-peer assessment for a total of 10 marks (on a scale of 1 to 10) and in the event of a group assignment the marks awarded will be the same for the entire group, the developmental assessment will be for a total of 20 marks and based on MCQ/case study/demonstration and such other assignment methods

Assessment framework for CIE (1 to 5)

Note : Theory to be conducted for 1 hour and practice for 3 hours, total duration of exam – 4 hours

Sample Questions For CIE-4

Programme	**Electronics & Communication Engineering**	**Semester**	**V**
Course	**E- Mobility**	**Max Marks**	**30**
Course Code	**20EC54I**	**Duration**	**4 hours**
Name of the course coordinator			

Note: Answer one full question from each section.

Qn.No	**Question**	**CL L3/L4**	**CO**	**PO**	**Marks**
	Section-1 (Theory) – 10 marks				
1.a)	"The batteries take up a lot of space in the EV car". Is this statement true or false. Justify your answer. How Batteries packs are placed in EV, Explain with neat sketch.	L3	2	1,3,7	5
b)	Explain why a Li-ion battery always produces 3.6V?	L4	4	1,3,7	5
2.a)	The customer is having 3-wheeler vehicle and found 2-wheeler charger when his EVs battery voltage is less, can he use the available charge? if yes what are the factors on which the charging process depends upon.	L4	2	1,3,7	5
b)	Recently many cases have been reported regarding catching of fire among various electric vehicles across the nation. Why is this scenario taking place, which part of the E -vehicle is causing thus mishap, how can this be controlled.	L3	4	1,3,7	5
	Section-2 (Practical) - 20 marks				
3)	Modelling of Electric vehicle batteries and battery pack by using simulation software.	L4	5	1,3,7	20
4)	Design a battery pack rated capacity 25Ah in a simulation software with C rate calculation.	L3	2,4	1,3,7	20

Note : Theory questions shall be aligned to practical questions

Assessment framework for SEE 1 (Theory)

Programme : Electronics & Communication Engineering
Semester : V
Course : E- Mobility. **Max Marks : 100**
Course Code : 20EC54I **Duration : 3 Hrs**

Instruction to the Candidate: Answer one full question from each section.

Q.No	Question	CL	CO	Marks
	Section-1			
1.a)	There are different drive train configurations in EV, with neat sketch explain any 2 types.	L3	1	10
b)	Analyse the economic and environmental impacts of using E – Vehicles in the modern-day society. Explain the role of EV's in reducing Greenhouse effect.	L4		10
2.a)	Compare, Draw and explain the ideal traction power plant characteristics in EV and IC vehicles.	L3		10
b)	A person sees a car which is being driven without a driver. Can this be possible? what is the technology involved. Explain in detail.	L3		10
	Section-2			
3.a)	Justify how rolling resistance effect the tire road contact in EV system.	L4	2	10
b)	The high voltage battery can be recharged when the brakes are applied in an EV. How is this energy transformation taking place. Explain the technology involved.	L4		10
4.a)	An EV owner while driving the vehicle observes that suddenly the steering system has lost its power feature and is very hard to operate. Explain the causes for the failure of the system and its solution.	L3		10
b)	While driving on a wet road, the E- vehicle is not stable, it goes to left direction, it goes to right direction, it drags, it skids. Driver is confused as to what is happening and how he can control the situation. Explain the concept & control system that needs to be used in this case and help the driver to gain control of the vehicle.	L3		10
	Section- 3			
5.a)	What are the parameters to be considered while designing the drivetrain of HEVs? Explain.	L3	3	10
b)	When you're driving and the air suddenly goes from comfortably cool to horribly hot, what might be the problem and how to solve this.	L4		10
6.a)	The range of an EV Vehicle is about 250km. The owner wants to increase the range as he is going on a family trip. How the range can be extended in an E- vehicle, explain the concept involved.	L3		10

b)	Power electronics plays a very important role in EV. Do you agree? If yes list all the components and technologies involved. justify your answer.	L3		10
Section-4				
7.a)	Can a super capacitor replace a battery? In what way it can be used in electric vehicles?	L3	4	10
b)	Why aren't the Metal air batteries are not used widely in spite of having many benefits. Analyse the possible causes.	L4		10
8.a)	What are the challenges for electrification of mobility in terms of charging infrastructure. Also discuss the load on the grid and how it has to be overcome.	L3		10
b)	In spite of hydrogen having high energy density, why hydrogen fuel cell is still not the preferred source of electric power and battery electric vehicles continue to dominate the EV market. Substantiate with statistics related to efficiencies.	L4		10
Section-5				
9.a)	In the car, the AC has kept ON but the driver notices that no air coming from the vent, what might be the problem and how to solve it.	L4	5	10
b)	Suppose a EV car owner is going for a drive and the car switches OFF abruptly. List the possible causes and analyse the solutions.	L3		10
10.a)	The battery charging process for an EV in a charging station is taking too long. List the parameters on which the charging process depends on. How can the charging process duration be minimized.	L4		10
b)	Energy management system improves the fuel economy and optimize the performance of HEV, is this statement true? Elaborate energy management system and issues of energy management strategies of EHV	L4		10

Scheme of Evaluation for SEE 2

Sl. No	Description	Marks
Problem Statement	Model an Electric vehicle by using simulation software and analyze the EV performance parameters such as a) speed, Torque, Top speed reached, SOC. b) Vehicle dynamics like rolling resistance, air drag, frontal area, weight of the body etc on EV performance	100
1	Modelling using Simulation software with integration of all the components/parts of an EV.	40
2	analyzing the integration process – logical flow of design, connections, etc	20
3	troubleshooting	20
4	Output	10
5	Viva voce	10
Total		**100**

Equipment / Software List with specification for a batch of 20 students

Sl No	**Equipment's**	**Specification**	**Quantity**
1	MAT LAB Simulink Software	as per industry standards.	1
2	Diagnostic Software for EV's	as per industry standards.	1