Structure & Syllabus
for

M. Tech. program in Electronics Engineering (Embedded Systems)

as per NEP2020 Guidelines

AY 2024-25

Programme Structure for M. Tech. Electronics Engineering (Embedded Systems) First Year
Semester I: Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		Th	Pr	Tu	Th	Pr	Tu	Total credits
P71PC101	Automotive Electronics-I	3	-	-	3	-	-	3
P71PC102	Embedded System Design	3	-	-	3	-	-	3
P71PC103	Industrial Automation	3	-	-	3	-	-	3
P71PE101	Program Specific Elective I	3	-	-	3	-	-	3
P01RM101	Research Methodology	2	-	-	-	2	-	2
PXXOE1XX	Open/Multidisciplinary Elective I:	2	-	-	2	-	-	2
P71VS101	Domain Specific Vocational Skills I: Open Source Programming	-	4	-	-	2	-	2
P71PC104	Automotive Electronics Lab	-	4	-	-	2	-	2
	Total	**16**	**08**	**-**	**14**	**6**	**-**	**20**

Th: Theory, Pr: Practical, Tu: Tutorial

Programme Structure for M. Tech. Electronics Engineering (Embedded Systems) First Year
Semester I: Evaluation Scheme

Course Code	Course Name	*Theory Marks*					*Practical Marks*		Total
		Internal Assessment				SEE	Term work	Practical Oral/POE	
		T1	T2	FET	Total				
P71PC101	Automotive Electronics-I	10	10	5	25	50	-	-	75
P71PC102	Embedded System Design	10	10	5	25	50	-	-	75
P71PC103	Industrial Automation	10	10	5	25	50	-	-	75
P71PE101	Program Specific Elective I	10	10	5	25	50	-	-	75
P01RM101	Research Methodology	-	10	5	15	35	-	-	50
PXXOE1XX	Open/Multidisciplinary Elective I	-	10	5	15	35	-	-	50
P71VS101	Domain Specific Vocational Skills I: Open Source Programming	-	-	-	-	-	50	-	50
P71PC104	Automotive Electronics Lab	-	-	-	-	-	25	25	50

FET – Faculty evaluation for Theory, T1, T2, Continuous Assessment Test, SEE - Semester End Examination

Programme Structure for M. Tech. Electronics Engineering (Embedded Systems) First Year
Semester II: Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		Th	Pr	Tu	Th	Pr	Tu	Total credits
P71PC201	Automotive Electronics-II	3	-	-	3	-	-	3
P71PC202	IOT System Design	3	-	-	3	-	-	3
P71PC203	Real Time Operating Systems	3	-	-	3	-	-	3
P71PE201	Program Specific Elective II	3	-	-	3	-	-	3
P01RM201	Research Publications and Ethics	2	-	-	2	-	-	2
PXXOE2XX	Open/Multidisciplinary Elective II	2	-	-	2	-	-	2
P71VS201	Domain Specific Vocational Skills II: VLSI Programming & Design	-	4	-	-	2	-	2
P71PC204	IOT System Design lab	-	4	-	-	2	-	2
	Total	**16**	**08**	**-**	**14**	**6**	**-**	**20**

Th: Theory, Pr: Practical, Tu: Tutorial

Programme Structure for M. Tech. Electronics Engineering (Embedded Systems) First Year
Semester II: Evaluation Scheme

Course Code	Course Name	*Theory Marks*					*Practical Marks*		Total
		Internal Assessment				SEE	Term work	Practical Oral/POE	
		T1	T2	FET	Total				
P71PC201	Automotive Electronics-II	10	10	5	25	50	-	-	75
P71PC202	IOT System Design	10	10	5	25	50	-	-	75
P71PC203	Real Time Operating Systems	10	10	5	25	50	-	-	75
P71PE201	Program Specific Elective II	10	10	5	25	50	-	-	75
P01RM201	Research Publications and Ethics	-	10	5	15	35	-	-	50
PXXOE2XX	Open/Multidisciplinary Elective II	-	10	5	15	35	-	-	50
P71VS201	Domain Specific Vocational Skills II: VLSI Programming & Design	-	-	-	-	-	50	-	50
P71PC204	IOT System Design Lab	-	-	-	-	-	25	25	50

FET – Faculty evaluation for Theory, T1, T2, Continuous Assessment Test, Term, SEE - Semester End Examination

Exit Option: Students who exit at the end of first year shall be awarded a PG Diploma after successful completion of first year with additional 4 credits earned through industry internship/field work/ vocational training/generic course/(s).

Programme Structure for M. Tech. Electronics Engineering (Embedded Systems) Second Year

Semester III: Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		Th	Pr	Tu	Th	Pr	Tu	Total credits
P71PC301	MOOC I	3	-	-	3	-	-	3
P71PC302	MOOC II	3	-	-	3	-	-	3
P71PR301	Dissertation Phase I	-	-	-	-	6	-	6
P71OT301	Industry Internship	-	-	-	-	8	-	8
	Total	**6**	**-**	**-**	**06**	**14**	**-**	**20**

Th: Theory, Pr: Practical, Tu: Tutorial

Semester III: Evaluation Scheme

Course Code	Course Name	*Theory Marks*					*Practical Marks*		Total
		Internal Assessment				SEE	Term work	Practical Oral/POE	
		T1	T2	FET	Total				
P71PC301	MOOC I	-	-	-	-	50	25	-	75
P71PC302	MOOC II	-	-	-	-	50	25	-	75
P71PR301	Dissertation Phase I	-	-	-	-	-	100	50	150
P71OT301	Industry Internship	-	-	-	-	-	150	50	200

FET – Faculty evaluation for Theory, T1, T2, Continuous Assessment Test, SEE - Semester End Examination

Semester IV: Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		Th	Pr	Tu	Th	Pr	Tu	Total credits
P71PR401	Dissertation Phase II		-	-	-	20	-	20
	Total	**-**	**-**	**-**	**-**	**20**	**-**	**20**

Th: Theory, Pr: Practical, Tu: Tutorial

Semester IV: Evaluation Scheme

Course Code	Course Name	*Theory Marks*					*Practical Marks*		Total
		Internal Assessment				SEE	Term work	Practical Oral/POE	
		T1	T2	FET	Total				
P71PR401	Dissertation Phase II					-	350	150	500

FET – Faculty evaluation for Theory, T1, T2, Continuous Assessment Test, SEE - Semester End Examination

OR

Programme Structure for M. Tech. Electronics Engineering (Embedded Systems) Second Year
Semester III: Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		Th	Pr	Tu	Th	Pr	Tu	Total credits
P71RP301	Dissertation Phase I – Research	-	-	-	-	20	-	20
	Total	**-**	**-**	**-**	**-**	**20**	**-**	**20**

Th: Theory, Pr: Practical, Tu: Tutorial

Semester III: Evaluation Scheme

Course Code	Course Name	*Theory Marks*					*Practical Marks*		Total
		Internal Assessment				SEE	Term work	Practical Oral/POE	
		T1	T2	FET	Total				
P71RP301	Dissertation Phase I – Research	-	-	-	-	-	350	150	500

FET – Faculty evaluation for Theory, T1, T2, Continuous Assessment Test, SEE - Semester End Examination

Programme Structure for M. Tech. Electronics Engineering (Embedded Systems) Second Year
Semester IV: Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		Th	Pr	Tu	Th	Pr	Tu	Total credits
P71RP401	Dissertation Phase II – Research		-	-	-	20	-	20
	Total	**-**	**-**	**-**	**-**	**20**	**-**	**20**

Th: Theory, Pr: Practical, Tu: Tutorial

Semester IV: Evaluation Scheme

Course Code	Course Name	*Theory Marks*					*Practical Marks*		Total
		Internal Assessment				SEE	Term work	Practical Oral/POE	
		T1	T2	FET	Total				
P71RP401	Dissertation Phase II - Research					-	350	150	500

FET – Faculty evaluation for Theory, T1, T2, Continuous Assessment Test, SEE - Semester End Examination

Programme Structure for M. Tech. Electronics Engineering (Embedded Systems)

Open/Multidisciplinary Elective

Sr.No	Course Code	Open/Multidisciplinary Elective- I	Credits
1.	P71OE101	Electronics measurements and instrumentation	2
		Open/Multidisciplinary Elective- II	
2.	P71OE102	Remote Sensing and Imaging	2

Programme Structure for M. Tech. Electronics Engineering (Embedded Systems)

Program Specific Elective

Sr.No	Course Code	Program Specific Elective - I	Credits
1.	P71PE101	Intelligence Systems	3
2.	P71PE102	Machine Learning	3
		Program Specific Elective - II	
1.	P71PE201	Embedded System Design using FPGA	3
2.	P71PE202	Deep Learning	3

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
P71PC101	Automotive Electronics -I	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		
P71PC101	Automotive Electronics -I	T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
		10	10	5	25	40%	50	40%	75

Course Description: This course focuses on transducers and sensors used in automobiles, the electronic systems used for automation and batteries used in automobiles.

Pre-requisites: Electronics measurements, sensors and instrumentation

Course Objectives:

1. Provide the most fundamental knowledge to the students so that they can understand the automotive electronics.
2. Explore use cases and applications of automotive electronics.

Course Outcomes

At the end of this course students will be able to:

CO1 Elaborate automotive architecture

CO2 Analyze gasoline engine management

CO3 Apply requirements of charging systems for Vehicles

CO4 Implement basic sensor arrangement for Vehicles

Course Contents

Module	Unit	Description	Hours
1.0		**Transducer Principles**	
1	1.1	Transducers classification and basic principles, General Input-output configuration, static and dynamic characteristics of instruments.	9
	1.2	Variable resistance transducers, Metal and semiconductor strain gages and their signal conditioning, Inductive transducers, Electromagnetic sensors, Hall effect sensors, Capacitive transducers, Piezo electric transducers and their signal conditioning, Ultrasonic sensors.	
2.0		**Electronics in the Automobile**	
2	2.1	Automotive Architecture, Overview Auto electrical and Electronics systems: Starting and Charging system, HMI & Instrumentation, Lighting System, Switches, Power and Signal Distribution, Safety and Security.	9
3.0		**Powertrain Electronic Systems**	
3	3.1	Gasoline Engine Management (EMS ECU), Diesel Engine Management system (EMS ECU), Transmission Control (TCU), Gasoline engine management, Infotainment electronics: Dashboard/instrument cluster, car audio, telematic systems navigation systems multimedia systems cross application technologies.	9
4.0		**Sensors for Automobile**	
4	4.1	Basic sensor arrangement, types of sensors such as- oxygen sensors, crank angle position sensors- Fuel metering vehicle speed sensors and destination sensors, Altitude sensor, Flow sensor, exhaust temperature, air mass flow sensors. Throttle position sensor, solenoids, stepper motors, relays, Steering wheel angle sensor, Vibration and acceleration sensors, Pressure sensors, Speed and RPM sensors, torque sensors.	9
5.0		**Batteries and Charging systems**	
5	5.1	Vehicle Batteries and Types, maintenance and charging, diagnosing Lead acid battery faults, advanced battery technology, new developments in electrical storage and batteries.	9
	5.2	Requirements of charging systems, generation of electrical energy in motor vehicle, physical principles, alternators-characteristic curves, charging circuits –diagnosing charging system faults –advanced charging system technology –new developments	

Text Books

1 "Automotive Electrics, Automotive Electronics: Systems & Components", 4th Ed., BOSCH. 2005
2 Ronald K. Jurgen, "Sensors and Transducers", 2nd Edition, SAE, 2003.

Reference:

1. Ernest O. Doebelin, "Measurement Systems – Application and Design", 4th Edition, McGraw-Hill, 2000
2. Automotive Sensors, BOSCH. 2002

- Internal Assessment (T1, T2 and FET):

1.T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules, for 10 marks each.

2.Fifth module (MCQ quiz) will be assessed for 5 marks separately.

- End Semester Examination:

1. Question paper will comprise of 5 questions, each carrying 10 marks.
2. The duration of end semester examination shall be 2 hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
P71PC102	Embedded System Design	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		
P71PC102	Embedded System Design	T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
		10	10	5	25	40%	50	40%	75

Course Description: This course focuses on LPC2148 microcontroller for developing advanced embedded systems and introduction of real time operating systems.

Pre-requisites: Digital electronics and circuit design, Microprocessors & Microcontrollers.

Course Objectives:

1. Provide the most fundamental knowledge to the students so that they can understand the embedded systems and their design.
2. Explore use cases and applications using LPC2148 and ARM Processors.

Course Outcomes

At the end of this course students will be able to:

CO1 Summarize evaluation of embedded systems and design issues

CO2 Develop small scale embedded system using LPC2148

CO3 Outline the features and capabilities of ARM Cortex M0/M0+ Microcontrollers

CO4 Demonstrate the capabilities of PSoC4 BLE SoC.

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction to Embedded Systems & ARM Processor**	
1	1.1	Embedded system (ES) definition, Embedded System Evaluation, ES Types with examples, Distinguish a Real Time Embedded System from other systems, Components of an Embedded system, Embedded system design issues & Design flow, a comparative study ARM7TDMI, ARM8, ARM9TDMI, ARM10TDMI, ARM11	9
2.0		**LPC 2148 Microcontroller**	
2	2.1	ARM7TDMI-S microcontroller, LPC-2148: Architecture details, I/O ports, Timers, PWM module, ADC and Interrupts.	9
3.0		**Interfacing External Peripherals to LPC 2148**	
3	3.1	Interfacing and Embedded C programming for LED's, LCD, Relay, Switch, Matrix keyboard, Stepper motor	9
4.0		**ARM Coterx M0/M0+ architecture**	
4	4.1	Introduction to ARM Cortex family, block diagram of the Cortex_-M0 & M0+, Advantages of ARM Cortex M0/M0+ processor, Introduction to CMSIS, Bus system, Memory mapping, Interrupts and exceptions.	9
5.0		**ARM Cortex M0 based PSoC4-BLE architecture**	
5	5.1	Introduction, I/O System, chip operational modes, power modes, WDT, Serial Communication Block (SCB), Universal Digital Block (UDB), Analog to Digital Converter, Timer, Counter and PWM.	9
	5.2	Introduction to Bluetooth Low Energy Subsystem (BLESS).	

Text Books

1. "ARM System Developers Guide- Designing & Optimizing System Software", Andrew N, Dominic Sloss, and Chris Wright, Elsevier, 2010.
2. LPC2148 User guide and reference manual-UM10139, Rev.4-2012
3. "Programmable Microcontrollers with Applications" Cem Ünsalan and H. Deniz Gürhan, Mc Graw Hill Education, 2014

Reference:

1. MSP430x2xx Family User's Guide, Texas Instruments, Literature Number: SLAU144J December 2004–Revised July 2013
2. "The Definitive Guide to ARM® Cortex®-M0 and Cortex-M0+ Processors", Joseph Yiu, Second Edition, Elsevier,2015
3. PSoC-4 Architecture TRM (Technical Reference Manual), Document No: 001-92738 Rev. *D, May 31, 2017 and Document No. 001-85634 Rev. *F, May 30, 2017

- Internal Assessment (T1, T2 and FET):

1.T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules, for 10 marks each.

2.Fifth module (MCQ quiz) will be assessed for 5 marks separately.

- End Semester Examination:

1. Question paper will comprise of 5 questions, each carrying 10 marks.
2. The duration of end semester examination shall be 2 hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
P71PC103	Industrial Automation	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		03	-	-	03	-	-

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		
P71PC103	Industrial Automation	T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
		10	10	5	25	40%	50	40%	75

Course Description: This course focuses on various automation techniques for Industrial automation in different sectors.

Pre-requisites: Basics of automation.

Course Objectives:

1. Provide the automation knowledge to the students so that they can understand the various industrial automation using PLC, DCS and SCADA etc.

2. Explore use cases and applications using PLC, DCS and SCADA etc.

Course Outcomes

At the end of this course students will be able to:

CO1 Describe the Programmable Logic Controller (PLC) and their programming languages

CO2 Explain the architecture and local control unit of Distributed Control System (DCS) and various industrial applications

CO3 Explain basic SCADA System Hardware, Software and Protocols.

Course Contents

Module	Unit	Description	Hours
1.0		**Industrial Automation Processes**	
1	1.1	Physical Process, Types of Industrial Processes, Industry Classification, Process Automation System, Needs Met by automation, Advantages of Automation, Steps of Automation, Process Signals, Main Components of Industrial Automation	9
2.0		**Programmable Logic Controller Basics And PLC Programming**	
2	2.1	Overview of PLC systems, parts of PLC, Input/Output modules, power supplies and isolators, Fundamental PLC wiring diagram, relays, switches, transducers, sensors, seal-in circuits. Fundamentals of logic, Program scan, Relay logic, PLC programming languages, Digital logic gates, Boolean algebra PLC programming.	9
3.0		**Common Configurations of DCS**	
3	3.1	Introduction, Common configurations, Distributed Control System, Network Control System, An engineering station, System/project tree structure DCS system database, Configuration of control functions, Configuration of operator/monitoring functions, Configuration of system hardware structure, Configuration of system software, Documentation, Commissioning	9
4.0		**DCS Applications, Implementation, And Future Trends**	
4	4.1	**Applications:** Use of DCS in pulp and paper environment, Use of DCS in petroleum-refining environment, Use of DCS in oil and gas processing environment, DCS Applications in power plants, Iron plant, steel plant, Cement plant.	9
	4.2	**Implementation:** System strategy, Automation plan, Project implementation, Installation and commissioning, Change management	
	4.3	**Future Trends:** Introduction, Creation of E-commerce solution.	
5.0		**SCADA Systems Hardware & Firmware**	
5	5.1	Introduction, History of SCADA, Fundamental Principles of Modern SCADA Systems, SCADA Hardware and Software, Comparison of the terms SCADA, DCS, PLC and smart instrument, Considerations and benefits of SCADA system, Remote Terminal unit(RTU), Application Programs, PLCs used as RTUs, The Master Station, Master Terminal unit	9

		(MTU),System Reliability and Availability, Communication Architecture, Configuration of MTU	

Text Books:

1 Programmable Logic Controllers: Principles and Applications, John W. Webb and Ronald A.Reis, Prentice – Hall India publication

2 Overview of Industrial Process Automation, KLS Sharma, Elsevier Publication

3 Practical SCADA for Industry, David Bailey, Elsevier Publication

4 Instrument Engineers' Handbook, B. G. Liptak

5 Practical Distributed Control Systems (DCS) for Engineers and Technicians, IDC Technologies

Reference Books:

1. Programmable logic controller, Frank D. Petruzella, Tata McGraw-Hill publication
2. Distributed Computer Control for Industrial Automation, Vijay P. Bhatkar
3. Programmable Logic Controllers, W. Bolton, Elsevier Newnes publication
4. Computer Based Industrial Control, Krishna Kant, PHI
5. Computer Aided Process Control, S.K.Singh, PHI

Learning website:

- http://nptel.iitm.ac.in/courses.php

- http://coep.vlab.co.in/?sub=33&brch=97

- http://www.plcmanual.com/

- Internal Assessment (T1, T2 and FET):

1. T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules, for 10 marks each.

2. Fifth module (MCQ quiz) will be assessed for 5 marks separately.

- End Semester Examination:

1. Question paper will comprise of 5 questions, each carrying 10 marks.

2. The duration of end semester examination shall be 2 hours.

3. The students need to solve all 5 questions.

4. Question No.1 will be compulsory and based on entire syllabus.

5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
P71PE101	Program Specific Elective I Intelligence Systems	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		
P71PE101	Program Specific Elective I Intelligence Systems	T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
		10	10	5	25	40%	50	40%	75

Course Description: This course focuses on using artificial neural networks and fuzzy logic for developing intelligent systems.

Pre-requisites: Linear Algebra, Mathematical modelling.

Course Objectives:

1. Provide the most fundamental knowledge to the students so that they can understand the artificial neural networks and fuzzy systems.
2. Explore use cases and applications of artificial neural networks and fuzzy systems.

Course Outcomes

At the end of this course students will be able to:

CO1 Choose algorithms of multilayer neural networks.

CO2 Distinguish between various training algorithms

CO3 Plan a neural network model for particular application.

CO4 Illustrate the different systems developed using fuzzy logic.

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction and Basic Concepts**	
1	1.1	Introduction- Humans and Computers, the structure of the brain, learning in machines, the differences. The basic neuron.	9
	1.2	Modelling the single neuron, learning in simple neurons, the perception: a vectoral Perspective, the perception learning rule, proof, limitations of perceptron,	
2.0		**Multilayer Networks**	
2	2.1	The multi-layer perceptron: Introduction, altering the perception model, the new model, the new learning rule, multi-layer perception algorithm, XOR problem. Multi-layer feed forward networks	9
3.0		**Back propagation training algorithm**	
3	3.1	Backpropagation algorithm , limitations of back propagation, Boltzman training, Cauchy training, combined back propagation. Numerical problems.	9
4.0		**Resonant Networks and Applications**	
4	4.1	Hop-field networks: recurrent and bi-directional associative memories, counter propagation network, Artificial Resonance Theory (ART) Application of neural network: Hand written digit and character recognition- Traveling sales man problem, a neuro-controller.	9
5.0		**Fuzzy Set Theory and Fuzzy Logic systems**	
5	5.1	Introduction to fuzzy set theory: Fuzzy set vs Crisp set, properties of fuzzy sets, operations on fuzzy set – fuzzy compliments, fuzzy intersection- T-norms, fuzzy union- t- co-norm, fuzzy relations.	9
	5.2	**Fuzzy Logic and Systems:** Fuzzy Logic: Classical logic, multi valued logic, fuzzy propositions, fuzzy quantifiers, linguistic hedges and their inferences. Fuzzy systems: fuzzy controllers, fuzzy systems and neural networks, fuzzy neural networks, fuzzy automata, fuzzy dynamic system.	

Text Books

1. Kosko B, "Neural Networks and Fuzzy Systems: A dynamical system approach to machine intelligence", Prentice Hall of India, 2009..
2. R Beale & T Jackson, "Neural Computing, An Introduction", Adam Hilger, 1990.
3. G.J.Klir & Bo Yuan, "Fuzzy Sets and Fuzzy Logic Theory and Applications", Prentice Hall of India, 2009.

Reference

1. Rao V.B and Rao H.V., "C++, Neural Networks and Fuzzy Logic", BPB Publications, 2003.
2. Simon Kendal, Malcolm Green, "An Introduction to Knowledge Engineering", Springer-Verlag Limited, 2007.
3. Timothy S.Ross, "Fuzzy Logic with engineering applications", Weily India Pvt. Ltd., 2011.

- Internal Assessment (T1, T2 and FET):

1.T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules, for 10 marks each.

2.Fifth module (MCQ quiz) will be assessed for 5 marks separately.

- End Semester Examination:

1. Question paper will comprise of 5 questions, each carrying 10 marks.
2. The duration of end semester examination shall be 2 hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
P71PE102	Program Specific Elective I Machine Learning	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		
P71PE102	Program Specific Elective I Machine Learning	T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
		10	10	5	25	40%	50	40%	75

Course Description: This course focuses on designing and developing artificial intelligence algorithms for machine learning.

Pre-requisites: Linear Algebra, Probability theory, Mathematical modelling.

Course Objectives:

1. Provide the most fundamental knowledge to the students so that they can understand the artificial neural networks algorithms for machine learning.
2. Explore use cases and applications of artificial neural networks algorithms for machine learning.

Course Outcomes

At the end of this course students will be able to:

CO1 Elaborate machine learning concepts, technologies, and applications

CO2 Analyse the underlying principle of soft computing with its usage in application

CO3 Illustrate machine learning tools to solve real life problems

CO4 Develop application on different machine learning techniques like GA and ANN.

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction to Machine Learning**	
1	1.1	What is Machine Learning? Difference between Hard and Machine Learning, Requirement of Soft computing, Major Areas of Machine Learning, Applications of Machine Learning.	9
	1.2	Artificial Neural networks – biological neurons, Basic models of artificial neural networks, connections, learning, activation functions, McCulloch and Pitts Neuron, Hebb network	
2.0		**Adaptive Networks**	
2	2.1	Architecture, Back propagation for feed forward networks, Extended back propagation for recurrent networks, Hybrid learning rule. Perceptron Networks Learning rule, Training and testing algorithm.	9
3.0		**Artificial Neural Networks: Supervised Learning**	
3	3.1	Introduction and how brain work, Neuron as a simple computing element, The perceptron, Back propagation networks: architecture, multilayer perceptron, back propagation learning-input layer, accelerated learning in multilayer perceptron, The Hopfield network, Bidirectional associative memories (BAM), RBF Neural Network.	9
4.0		**Artificial Neural Networks: Unsupervised Learning**	
4	4.1	**Artificial Neural Networks: Unsupervised Learning:** Hebbian Learning, Generalized Hebbian learning algorithm, Competitive learning, Self-Organizing Computational Maps: Kohonen Network.	9
5.0		**Genetic Algorithm**	
5	5.1	Genetic algorithms basic concepts, encoding, fitness function, reproduction- Roulette wheel, Boltzmann, tournament, rank, and steady state selections, Convergence of GA, Applications of GA case studies. Introduction to genetic programming- basic concepts	9

Text Books

1. Kosko B, "Neural Networks and Fuzzy Systems: A dynamical system approach to machine intelligence", Prentice Hall of India, 2009..
2. D. E. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley
3. Kumar S., Neural Networks - A Classroom Approach, Tata McGraw Hill, 2004.

Reference

1. R. Rajasekaran and G. A Vijayalakshmi, Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, Prentice Hall of India
2. Simon Kendal, Malcolm Green, "An Introduction to Knowledge Engineering", Springer-Verlag Limited, 2007.

- Internal Assessment (T1, T2 and FET):

1.T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules, for 10 marks each.

2.Fifth module (MCQ quiz) will be assessed for 5 marks separately.

- End Semester Examination:

1. Question paper will comprise of 5 questions, each carrying 10 marks.
2. The duration of end semester examination shall be 2 hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
P01RM101	Research Methodology	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		
P01RM101	Research Methodology	T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
			10	5	15	40%	35	40%	50

Course Description

This course will provide an opportunity for participants to establish or advance their understanding of research through critical exploration of research language, ethics, and approaches. The course introduces the language of research, ethical principles and challenges, and the elements of the research process within quantitative, qualitative, and mixed methods approaches.

Pre-requisites: NIL

Course Objectives

- Understand the types of research and their applications and research process arising in many engineering problems.
- Practice the ethical standards in research
- Understand Computation of Jacobian of functions of several variables and their applications.

Course Outcomes: After the successful completion of the course students will able to:

CO1 Explain the types of research and their applications and research process

CO2 Demonstrate the ethical standards in research

CO3 Identify and state the research problem clearly

CO4 Design carry out research literature review and identify gaps in literature pertaining to a particular research issue.

Course Contents

Module	Unit	Description	Hours
1.0		**Research Fundamentals and Types**	9
1	1.1	Definition and objectives of Research: Research method and research methodology, Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Philosophy and validity and reliability of research. Objective of research. Types of Research: Pure and applied research. Descriptive and explanatory research. Qualitative and quantitative approaches Ethical Issues in research	
2.0		**Research Process and Research Modelling**	9
2	2.1	Steps in research process Formulating the Research Problem, Literature Review, Developing the objectives, Preparing the research design including sample Design Relevance, interest, available data, choice of data, Analysis of data, Generalization and interpretation,	
3.0		**Outcomes of research**	9
3	3.1	Design of sample surveys Sampling design, measurement and scaling, data collection, data preparation and data analysis using various techniques Research outcomes Research papers and Publications	
4.0		**Hypothesis Formulation and Testing**	9
4	4.1	Probability distributions. Type I and II error, testing of mean, proportion, tests for equality of mean and variances of two populations, confidence interval, Z test and $\chi 2$ test for goodness of fit, ANOVA (one-way classification),	
	4.2	Non-parametric tests: sign test, U test. Correlation and Regression Analysis: Karl Pearson's and Rank Correlation coefficient, simple linear regression: least squares method	
5.0		**Interpretation and Report Writing**	9
5	5.1	Meaning Of Interpretation, Why Interpretation?, Technique Of Interpretation, Precautions In Interpretation, Significance of report writing, Different Steps In Writing Report, Layout Of The Research Report, Mechanics Of Writing A Research Report, Precautions For Writing Research Report	

Text Books

1. Kothari C R, Research Methodology (Methods and Techniques), 2004, New Age International Publishers, New Delhi.

References

1. Pannnerselvam, R Research Methodology, 2014, Phi Learning Private Limited, Delhi.
2. Saravanavel P, Research Methodology, 2011, Kitab Mahal, Allahabad.
3. Kumar R. Research Methodology, 2011, SAGE Publications Asia-Pacific Ptd Singapore.
4. Singh Yogesh Kumar, 2011, Fundamental of Research Methodology and Statitics, New Age International Publishers, New Delhi.
5. Michael V P 2000, Research Methodology in Management Himalaya Publishing House, Mumbai.

Internal Assessment (T1, T2 and FET)

1. T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules, for 10 marks each.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 50 marks comprise of 5 questions, each carrying 10 marks.
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
P71OE101	Open/Multidisciplinary Elective I- Electronics measurements and instrumentation	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		
P71OE101	Open/Multidisciplinary Elective I- Electronics measurements and instrumentation	T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
			10	5	15	40%	35	40%	50

Course Description

This course provides a thorough review of the electronic devices and measuring methods that are necessary for engineering applications. The principles of operation, applications, and wide range of measuring devices in various sectors of electronics will all be thoroughly understood by the students. The course will prepare students for real-world problems in engineering and research by emphasizing practical expertise with electronic instrument use and measurement result interpretation.

Pre-requisites: Basics of Electrical & Electronics

Course Objectives

1. Understand the Principles of Electronic Instruments:
2. Operate Analog and Digital Measurement Instruments
3. Apply Signal Generators and Analyzers in Practical Scenarios

Course Outcomes: After the end of this course students will be able to

CO1 Understand the Principles of Electronic Instruments

CO2 Analyze the Operation of Analog Measurement Instruments

CO3 Explore Digital Measurement Instruments

CO4 Apply Signal Generators and Analyzers in Practical Scenarios

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction to Electronic Instruments**	**6**
1	1.1	Overview of electronic instruments and their significance in measurement, Classification of electronic instruments: analog and digital, Basic principles of measurement. Calibration and standards in electronic measurements, Sources of errors in electronic	
2.0		**Analog and Digital Instruments**	**6**
2	2.1	Ammeters and voltmeters: principles, types, and Applications, Ohmmeters and multimeters: functionality and usage Analog oscilloscopes: features, controls, and applications Measurement of frequency and phase with analog instruments, Introduction to digital multimeters	
3.0		**Introduction to Signal Generators**	**6**
3	3.1	Basics of signal generators: purpose and types, Common waveforms: sine, square, triangle, and sawtooth, Frequency synthesis techniques	
	3.2	Amplitude, frequency, and phase modulation Applications of signal generators in electronics and communication.	
4.0		**DC and AC Bridge Circuits**	**6**
4	4.1	Wheatstone bridge, Kelvin Bridge, Maxwell Bridge, Hay Bridge, Schering bridge, Desauty bridge and Wein bridge-Operation and Characteristics	
5.0		**Network Analysers**	**6**
5	5.1	Basics of network analysis, Types of network analysers: scalar and vector, Smith chart and impedance measurements	
	5.2	S-parameter measurements and interpretations, Calibration techniques for network analysers, Applications of network analysers in RF and microwave engineering	

Text Books

1. A course in Electrical, Electronics measurement and Instrumentation, A.K.Sawhney
2. Electronic Instrumentation, H. S. Kalsi, MGH, 3rd Edition

References

1. Electronic Instrumentation and Measurement Techniques, Welfrick Cooper
2. Instrumentation for Engineers And Scientists, John Turner ,II Edition , Wile
3. Electronic Instrumentation and Measurements, David A Bell, Third Edition, Oxford

- Internal Assessment (T1, T2 and FET):

1. T1 (Test 1) should be based on first two modules
2. Fifth module (MCQ quiz) will be assessed for 5 marks separately.

- End Semester Examination:
  1. Question paper will comprise of 5 questions, each carrying 7 marks.
  2. The duration of end semester examination shall be 2 hours.
  3. The students need to solve all 5 questions.
  4. Question No.1 will be compulsory and based on entire syllabus.
  5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
P71VS101	Domain Specific Vocational Skills I- Open Source Programming	Theory	Practical	Tutorial	Theory	Practical	Tutorial
			04	-	-	02	-

Evaluation Scheme

Course Code	Course Name	In Semester Evaluation		Semester End Exam (SEE) (OE/POE)		
P71VS101	Domain Specific Vocational Skills I- Open Source Programming	Term work	Min pass	Marks	Min pass	Total (Marks)
		50	40%	-	-	50

Course Description: This domain specific vocational course is prepared to impart employability skills aligned with the industry. In this python programming basic and lab sessions will be conducted. Students have to write the algorithm in python to solve a given task. The course contents more hands on lab sessions on python programming/open source software programming.
Pre-requisites: Basic knowledge of computer software programming.

Course Objectives:

1. To obtain knowledge on python programming.
2. To deal with morphological processing, syntactic parsing, information extraction.
3. To understand the functions of the python libraries for various applications.

Course Outcomes: After the end of this course students will be able to

CO1 Install the python IDE with its libraries

CO2 Write Python programs to manipulate and analyze data.

CO3 Select the data structures and algorithms that are used in python.

CO4 Demonstrate key concepts of Python programming for various applications.

Text Books

1. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron
2. "Machine Learning: A Probabilistic Perspective" by Kevin P. Murphy

Reference:

1. Python Machine Learning" by Sebastian Raschka and Vahid Mirjalili
2. "Introduction to Machine Learning with Python: A Guide for Data Scientists" by Andreas C. Müller and Sarah Guido

Experiment List

- Minimum 12 to 14 experiments/programs will be performed from the following list.

1. Program to demonstrate different number data types in Python.
2. Program to perform different Arithmetic Operations on numbers in Python.
3. Program to create, concatenate and print a string and accessing sub-string from a string.
4. Python script to print the date in the given format "Sun May 29 02:26:23 IST 2017"
5. Program to create, append, and remove lists in python.
6. Program to demonstrate working with tuples in python.
7. Program to demonstrate working with dictionaries in python.
8. Python program to find largest of three numbers.
9. Python program to convert temperature from Celsius to Fahrenheit & vice a versa.
10. Python program to construct the following pattern, using a nested for loop
11. Python script that prints prime numbers less than 20.
12. Python program to find factorial of a number using Recursion.
13. Write a program that accepts the lengths of three sides of a triangle as inputs. The program output should indicate whether or not the triangle is a right triangle (Recall from the Pythagorean Theorem that in a right triangle, the square of one side equals the sum of the squares of the other two sides).
14. Program to define a module to find Fibonacci Numbers and import module to another program.
15. Python program to define a module and import a specific function in module to another program.
16. Write a script named copyfile.py. This script should prompt the user for the names of two text files. The contents of the first file should be input and written to the second file.
17. Program that inputs a text file and print all of the unique words in the file in alphabetical order.
18. Write a Python class to convert an integer to a roman numeral.
19. Write a Python class to implement pow (x, n)
20. Write a Python class to reverse a string word by word.

Evaluation Scheme:

1. TERM WORK assessment must be based on the overall performance of the student with every assignment graded from time to time.

2. The grades will be converted to marks as per 'credit and grading system' manual and should be added and averaged.

3. Based on above scheme grading and TERM WORK assessment should be done.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
P71PC104	Lab I- Automotive Electronics Lab	Theory	Practical	Tutorial	Theory	Practical	Tutorial
			02	-	-	02	-

Evaluation Scheme

Course Code	Course Name	In Semester Evaluation		Semester End Exam (SEE) (OE/POE)		
P71PC104	Lab I- Automotive Electronics Lab	Term work	Min pass	Marks	Min pass	Total (Marks)
		25	40%	25	40	50

Course Description: This lab course focuses on transducers and sensors used in automobiles, the electronic systems used for automation and batteries used in automobiles. There is also detailed demonstration of latest fuel ignition systems and safety systems like SRS Airbags and ABS used in automobiles.

Pre-requisites: Electronics measurements, sensors and instrumentation

Course Objectives:

1. Provide the most fundamental knowledge to the students so that they can understand the automotive electronics.
2. Explore use cases and applications of automotive electronics.

Course Outcomes

At the end of this course students will be able to:

CO1 Elaborate automotive architecture

CO2 Illustrate gasoline engine management

CO3 Estimate requirements of charging systems for Vehicles

CO4 Demonstrate operation of fuel ignition and safety systems like SRS Airbags and ABS used in automobiles.

Experiment List:

- Minimum 12 to 14 experiments/programs will be performed from the following list.

1. Experiment on testing and study of different types of Batteries and constructions.
2. Testing, dismantling and assembling of starter motor used in automobile.
3. Testing, dismantling and assembling of alternator used in automobile.
4. Study of different colour code system used in automotive wiring system.
5. Study of battery ignition System and their parts used in Automobile Vehicles.
6. Demonstration Study and demonstrate lighting system of two-wheeler and Four-Wheeler.
7. Study of different Electrical Equipment's & Accessories (Speedometer, Warning lights, Electric Horn, Wind shield wipers system).
8. Study of different sensor used in modern automotive system.
9. Study and demonstrate the operation of Electronic ignition system,
10. Study and demonstrate the operation of Electronic fuel injection system,
11. Study and demonstrate the operation of Electronic fuel injection system
12. Study and demonstrate the operation SRS- Air bag protection system
13. Study and demonstrate the operation of Antilock Braking Systems (ABS).
14. Study and demonstrate diagnosis on ignition system.
15. Demonstration and experiment on automotive dashboard instruments.

- **Evaluation Scheme:**

1. TERM WORK assessment must be based on the overall performance of the student with every assignment graded from time to time.

2. The grades will be converted to marks as per 'credit and grading system' manual and should be added and averaged.

3. Based on above scheme grading and TERM WORK assessment should be done.

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Semester- II

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
P71PC201	Automotive Electronics -II	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		
P71PC101	Automotive Electronics -II	T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
		10	10	5	25	40%	50	40%	75

Course Description: This course focuses on transducers and sensors used in automobiles, the electronic systems used for ignition, convenience and safety in automobiles. It also involves study of basic electrical and advanced vehicle automation.

Pre-requisites: Electronics measurements, sensors and instrumentation

Course Objectives:

1. Provide the most fundamental knowledge to the students so that they can understand the automotive electronics.
2. Explore use cases and applications of automotive electronics and safety.

Course Outcomes

At the end of this course students will be able to:

CO1 Illustrate vehicle convenience and security systems.

CO2 Elaborate safety systems in automobiles.

CO3 Apply auto-motive embedded System

CO4 Make use of instrumentation and advances in automotive engineering

Course Contents

Module	Unit	Description	Hours
1.0		**Vehicle Convenience and Security Systems**	
1	1.1	Tyre pressure monitoring systems, Two-wheeler and Four-wheeler security systems, parking guide systems, anti-lock braking system, future safety technologies. Automatic parking system. Advanced driver assistance systems. Autonomous driving.	9
2.0		**Safety Systems in Automobiles**	
2	2.1	Vehicle diagnostics and health monitoring, Safety and Reliability, Traction Control, Vehicle Dynamics Control, accelerators and tilt sensors for sensing skidding and anti-collision - anti-collision techniques using ultrasonic Doppler sensors, Connected car system.	9
3.0		**MEMS based Automotive Sensors**	
3	3.1	Micro systems in Automobiles- an Overview, MEMS sensor over conventional Sensors, different types of MEMS based Sensors for Drivetrain Control, Safety Systems and Comfort Systems.	9
4.0		**Instrumentation and Advances in Automobile Engineering**	
4	4.1	Passenger comfort and security, Seat belts, Air bags, Automotive Electronics - Electronic Control Unit (ECU) - Active Suspension System (ASS) - Electronic Brake Distribution (EBD) – Electronic Stability Program (ESP).	9
5.0		**Electric and Hybrid vehicle**	
5	5.1	Electric - Hybrid vehicle introduction. Historical background, Types of EV's, Motor drive technologies, Energy source, EV's subsystems and configurations,	9
	5.2	Hybrid Electric Vehicle subsystems and configurations, HEV modes of operation	

Text Books

1 "Automotive Electrics, Automotive Electronics: Systems & Components", 4th Ed., BOSCH. 2005

2 Ronald K. Jurgen, "Sensors and Transducers", 2nd Edition, SAE, 2003.

Reference:

1. Ernest O. Doebelin, "Measurement Systems – Application and Design", 4th Edition, McGraw-Hill, 2000

2. Automotive Sensors, BOSCH. 2002

- Internal Assessment (T1, T2 and FET):

1.T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules, for 10 marks each.

2.Fifth module (MCQ quiz) will be assessed for 5 marks separately.

- End Semester Examination:

1. Question paper will comprise of 5 questions, each carrying 10 marks.
2. The duration of end semester examination shall be 2 hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
P71PC202	IoT System Design	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		
P71PC202	IoT System Design	T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
		10	10	5	25	40%	50	40%	75

Course Description: This course focuses on the understanding of Internet of Things (IoT) systems. It also involves basic steps in design and development of Internet of Things (IoT) systems. It also covers IoT application case studies in various fields of life.

Pre-requisites: Electronics sensors and instrumentation, Electronics Communication systems.

Course Objectives:

1. Provide the most fundamental knowledge to the students so that they can understand the Internet of Things (IoT) systems.
2. Explore use cases and applications of the Internet of Things (IoT) systems.

Course Outcomes

At the end of this course students will be able to:

CO1 Define the various concepts, terminologies and architecture of IoT systems.

CO2 Select sensor for given IoT domain.

CO3 Illustrate design & security challenges in IoT.

CO4 Design simple IoT system.

Course Contents

Module	Unit	Description	Hours
1.0		**Overview of IoT systems, Components of an IoT system**	
1	1.1	Introduction to IoT concept, Objective, IoT History, Introduction to IoT communication, Iot enabling technologies	9
		IoT Network Architecture and Design: - Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack, IoT Levels.	
2.0		**Embedded Platforms for IoT**	
2	2.1	Embedded computing basics, Overview of IOT supported Hardware platforms such as Arduino, NetArduino, Raspberry pi, Beagle Bone, Intel Galileo boards, ESPXX and ARM cortex, Particle boards.	9
3.0		**Wireless technologies for IoT (Layer 1 & 2)/Architecture**	
3	3.1	WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems, LoRaWAN, ZWave.	9
4.0		**IoT Edge to Cloud Protocols**	
4	4.1	**Message Queue Telemetry Transport (MQTT) and CoAP.** MQTT architecture details, packet structure, MQTT communication formats, MQTT-SN architecture and topology, Transparent and aggregating gateways, Gateway advertisement and discovery.	9
	4.2	**Constrained Application Protocol: -** Architecture, Messaging Formats, STOMP, AMQP, HTTP/RESTful	
5.0		**Challenges in IoT Design and IoT Applications**	
5	5.1	Development Challenges, Security Challenges, Power resource and Other challenges	9
	5.2	Smart Metering, E-health, City Automation, Automotive Applications, home automation, smart cards, mobiles, tablets, An IoT Strategy for Smarter Cities, Smart City IoT Architectures.	

Text Books

1. Vijay Medishctti. Arshadeep Bahga, "Internet Of Things; A Hands-On Approach", 1st Edition, Universities Press, 2014
2. Dr. Ovidiu Vermesan, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems," 1st edition, River Publishers, 2013.
3. Rajesh Singh, Anita Gehlot, Lovi Raj Gupta,Bhupendra Singh, and Mahendra Swain "Internet of Things With Raspberry Pi and Arduino", CRC Press, Taylor & Francis Group, 2020.

Reference:

1. Clino Pfister, "Getting Started with the Internet of Things", 1st Edition, Publisher Make:Community, 2011.
2. Parikshit Narendra Mahalle ,Poonam Railkar, " Identity Management for Internet of Things",1st Edition , River Publishers. 2015.

- Internal Assessment (T1, T2 and FET):

1.T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules, for 10 marks each.

2.Fifth module (MCQ quiz) will be assessed for 5 marks separately.

- End Semester Examination:

1. Question paper will comprise of 5 questions, each carrying 10 marks.
2. The duration of end semester examination shall be 2 hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
P71PC203	Real Time Operating System	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		
P71PC203	Real Time Operating System	T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
		10	10	5	25	40%	50	40%	75

Course Description: This course focuses on the concepts of real time operating systems and applications of real time operating systems.

Pre-requisites: Microprocessors architecture and programming, Operating system.

Course Objectives:

1. Provide the most fundamental knowledge to the students so that they can understand the real time operating systems fundamentals.
2. Explore use cases and applications of real time operating systems.

Course Outcomes

At the end of this course students will be able to:

CO1 Analyze software architectures and fundamental services in RTOS.

CO2 Estimate Worst Case Execution Time (WCET) of various tasks.

CO3 Explain threading basics and mutex fundamentals.

CO4 Determine the use of RTOS in developing applications.

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction to Real Time Operating Systems (RTOS)**	
1	1.1	Basics of RTOS: Real-time concepts, Hard Real time and Soft Real-time, Differences between General Purpose OS & RTOS.	9
	1.2	Embedded software architectures: Round robin, round robin with interrupts, Function queue scheduling and real time operating system, Basic architecture of an RTOS.	
2.0		**RTOS Fundamentals**	
2	2.1	Tasks and Task states, Semaphores, Shared data, Message queues, Mail boxes and pipes, Memory management , Interrupt routines,, Encapsulating semaphore and queues Task management, Dual role of time, Inter-task communication, Process input/output.	9
3.0		**Real Time Scheduling & Threads**	
3	3.1	Schedulability problem: classification, schedulability test, worst case execution time (WCET), static scheduling, dynamic scheduling, dependent tasks, independent tasks.	9
	3.2	Concept of threading, Multithreading models, threading issues, thread libraries, synchronization, Mutex: creating, deleting, prioritizing mutex, mutex internals.	
4.0		**Real Time Operating Systems**	
4	4.1	VX works - uCOS – POSIX standards - RT Linux – device drivers – Real time library of Keil IDE - RTOS Porting to a Target.	9
5.0		**RTOS Case studies**	
5	5.1	Free-RTOS architecture - Embedded RTOS for voice over IP – RTOS for fault Tolerant Applications – RTOS for Control Systems.	9

Text Books

1. Hermann Kopetz, "Real–Time systems – Design Principles for distributed Embedded Applications", Second Edition, Springer 2011..
2. Doug Abbott, "Linux for embedded and real time applications", Elsevier Science, 2003

Reference:

1. Embedded Software Primer by David Simon
2. Micro C OS II reference manual.
3. Keil Real Time library documentation

- Internal Assessment (T1, T2 and FET):

1.T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules, for 10 marks each.

2.Fifth module (MCQ quiz) will be assessed for 5 marks separately.

- End Semester Examination:

1. Question paper will comprise of 5 questions, each carrying 10 marks.
2. The duration of end semester examination shall be 2 hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
P71PE201	Program Specific Elective II- Embedded system design using FPGA	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		
P71PE201	Program Specific Elective II- Embedded system design using FPGA	T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
		10	10	5	25	40%	50	40%	75

Course Description: This course focuses on Field Programmable Gate Array (FPGA) devices, Very high speed hardware description logic (VHDL) and Verilog languages for designing Very large scale integration (VLSI) technology.

Pre-requisites: Knowledge in Digital circuit design and Microprocessors

Course Objectives:

1. To provide exposure to VLSI design.
2. To discuss VLSI design using FPGA
3. To illustrate how to apply FPGA for VLSI system design.

Course Outcomes: after the end of this course students will be able to

CO1 Summarize evaluation of FPGA devices and soft processors

CO2 Design a testable digital reconfigurable system using FPGA

CO3 Outline the features and capabilities of VHDL and Verilog

CO4 Demonstrate[4] different FPGA interfacing skills.

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction to FPGA Devices**	
1	1.1	Architecture of a FPGA, FPGA memory, Clock and PLL, Timing model and power analysis.	9
2.0		**FPGA-based Embedded Processor**	
2	2.1	Soft Processors-MicroBlaze, diagram, Hardware–Software Co-design flow, Creating a Customized Microcontroller.	9
3.0		**Introduction to VHDL**	
3	3.1	Need of HDL, Features and capabilities of VHDL, Elements of VHDL (Entity, Architecture, Library, Package, and Configuration), Identifiers, literals, data types, operators and Attributes	9
4.0		**Introduction to Verilog**	
4	4.1	Basic Verilog naming conventions, Verilog operators, data types, assignment statements, control statements, behavioral modeling in Verilog HDL, combinational and sequential logic design using Verilog.	9
5.0		**Interfacing and Prototyping with FPGA**	
5	5.1	LED, LCD, Seven Segment, ADC and DAC, Switch, Keypad, Stepper Motor Interfacing.	9
	5.2	Prototyping Using FPGA: Simulation and Verification, Debugging, FPGA Design Test Methodology, Hardware-in-the-loop Testing.	

Text Books

1. Wayne Wolf, ―FPGA-Based System Design, Prentice Hall Modern Semiconductor Design Series, 2004.
2. "Principals of Digital System Design using VHDL" Roth, John, Cengage Learning
3. "Fundamentals of Digital Logic with VHDL design" Stephen Brown and Zvonko Vranesic, Tata – Mcgraw Hill

Reference:

1. "Fundamentals of Digital Logic with Verilog design" Stephen Brown and Zvonko Vranesic, Tata – Mcgraw Hill
2. Rahul Dubey "Introduction to Embedded System Design Using Field Programmable Gate Arrays" ISBN 978-1-84882-015-9, Springer

- Internal Assessment (T1, T2 and FET):

1. T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules, for 10 marks each.

2. Fifth module (MCQ quiz) will be assessed for 5 marks separately.

- End Semester Examination:

1. Question paper will comprise of 5 questions, each carrying 10 marks.
2. The duration of end semester examination shall be 2 hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
P71PE202	Program Specific Elective II- Deep Learning	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		
P71PE202	Program Specific Elective II- Deep Learning	T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
		10	10	5	25	40%	50	40%	75

Course Description: This course is an introduction to deep learning, a branch of machine learning concerned with the development and application of modern neural networks. Deep learning algorithms extract layered high- level representations of data in a way that maximizes performance on a given task.

Pre-requisites: Knowledge in Linear Algebra and Probability, Machine learning

Course Objectives:

1. To provide exposure to deep learning topics
2. To discuss deep learning methods for working with sequential data
3. To illustrate how to apply such deep learning mechanisms to various learning problems

Course Outcomes: after the end of this course students will be able to

CO1 Understand the algorithmic topics of deep learning

CO2 Build application using Convolutional Neural Networks & Sequence modeling

CO3 Apply the Auto Encoders in practical applications

CO4 Use deep learning architectures for developing applications

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction To Deep Learning**	
1	1.1	History of Deep Learning, Introduction to deep Learning-Solving methodology, Deep learning software SVD applied on handwritten digits using scikit-learn, SVD applied on handwritten digits using scikit-learn, Deep Learning Success Stories, Logic, Perceptron Learning Algorithm and Convergence, Multilayer Perceptron(MLPs), Representation Power of MLPs	9
2.0		**Fundamentals Concepts of Machine Learning**	
2	2.1	Historical Trends in Deep Learning-Machine Learning Basics: Learning Algorithms-Supervised and Unsupervised Training, Testing, Cross-Validation, Over/Under-fitting, Hyper parameters and validation sets, Estimators, Bias, Variance, Regularization-Introduction to a simple DNN, Platform for deep learning, Deep learning software libraries.	9
3.0		**Deep Feed Forward Networks**	
3	3.1	Deep feed forward networks- Introduction-Learning XOR-Gradient-Based Learning-Various Activation Functions, error functions- Architecture Design-differentiation algorithms- Regularization for Deep learning- Early Stopping, Drop out.	9
4.0		**Convolutional Neural Networks and Recurrent Neural Networks**	
4	4.1	Convolutional layers, Object Detection, Kernel, Cross-correlation and convolution operation, Padding, Stride, Pooling, Image augmentation, SGD for CNNs, 3D CNNs, Sequence Modeling, RNN Models, LSTM	9
5.0		**Auto Encoders & Deep Architectures In Vision**	
5	5.1	Auto encoders - Auto encoders: under complete, regularized, stochastic, denoising, contractive, applications – dimensionality reduction, classification, recommendation, Optimization for Deep Learning: optimizers. RMS Prop for RNNs	9
	5.2	Deep Architectures in Vision - Alexnet to ResNet, Transfer learning, Siamese Networks, Metric Learning, Ranking/Triplet loss, RCNNs, CNN-RNN, Applications in captioning and video tasks , Generative adversarial networks	

Text Books

1.Ian Goodfellow, YoshuaBengio, Aaron Courville, Deep Learning, MIT Press, 2016
(available at http://www.deeplearningbook.org)
2.Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012

Reference:

1. Michael Nielsen, Neural Networks and Deep Learning, Online book, 2016
(http://neuralnetworksanddeeplearning.com/)
2. Jason Brownlee , Deep Learning with Python, Ebook, 2016

- Internal Assessment (T1, T2 and FET):

1. T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules, for 10 marks each.

2. Fifth module (MCQ quiz) will be assessed for 5 marks separately.

- End Semester Examination:

1. Question paper will comprise of 5 questions, each carrying 10 marks.
2. The duration of end semester examination shall be 2 hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)	Credits Assigned

P01RM201	Research Publications and Ethics	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		
P01RM201	Research Publications and Ethics	T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
			10	5	15	40%	35	40%	50

Course Description

This course will provide an opportunity for participants to establish or advance their understanding of research through critical exploration of research language, ethics, and approaches.

Course Objectives

- To know research ethics.
- To understand research approaches and their applications.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Identify**[4] the ethical standards in research
- **CO2** **Analyse**[4] research literature review and identify gaps in literature pertaining to a particular research issue.
- **CO3** **Design**[5] and conduct research
- **CO4** **Describe**[6] the outcomes of research by preparing a paper for publication or patenting

Course Contents

Module	Unit	Description	Hours
1.0		**Publication ethics:**	**9**
1	1.1	definition, introduction, and importance - best practices / standards setting initiatives and guidelines: COPE, WAME, etc. - Conflicts of interest -	
	1.2	Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types - Violation of publication ethics, authorship, and contributor ship - Identification of publication misconduct, complaints, and appeals - Predatory publisher and journals.	
2.0		**Ethics with respect to science and research -**	**9**
2	2.1	Intellectual honesty and research integrity - Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP) - Redundant Publications: duplicate and overlapping publications,	
	2.2	salami slicing - Selective reporting and misrepresentation of data.	
3.0		**Open access publications and initiatives -**	**9**
3	3.1	SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies - Software tool to identify predatory publications developed by SPPU - Journal finger / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer, Journal Suggester, etc.	
4.0		**Databases:**	**9**
4	4.1	Indexing databases, Citation databases: Web of Science, Scopus, etc. Research Metrics: Impact Factor of journal as per Journal Citations Report, SNIP, SJR, IPP,.	
	4.2	Cite Score - Metrics: h-index, g index, i10 Index, altmetrics	

Text Books

1. Gupta S. C. and Kapoor V. K, Fundamentals of Mathematical Statistics, Sultan Chand & Company New Delhi.
2. Creswell, J. W. Research design: Qualitative, quantitative, and mixed methods approach. 5th Ed. Thousand Oaks, CA: Sage, 2018.

References

1. Nicholas H. Steneck. Introduction to the Responsible Conduct of Research. Office of Research Integrity. 2007. Available at: https://ori.hhs.gov/sites/default/files/rcrintro.pdf
2. Anderson B.H., Dursaton, and Poole M.: Thesis and assignment writing, Wiley Eastern 1997.
3. Gupta S. C. and Kapoor V. K, "Fundamentals of Mathematical Statistics", Sultan Chand & Company New Delhi.

Internal Assessment (T1, T2 and FET)

1. T1 (Test 1) should be based on first two modules for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 07 marks.
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
P71OE201	Open/Multidisciplinary Elective II- Remote Sensing and Imaging	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		
P71OE201	Open/Multidisciplinary Elective II- Remote Sensing and Imaging	T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
		-	10	5	15	40%	35	40%	50

Course Description

This course provides a comprehensive knowledge of remote sensing and imaging by using active and passive sensors. The course will prepare students for real-world problems in engineering and research by emphasizing expertise with ranging and imaging techniques.

Pre-requisites: Basics of sensors and instrumentation

Course Objectives

1. Understand the Principles of remote sensing and imaging
2. Provide fundamental knowledge of ranging and imaging sensors for detection of signal.

Course Outcomes: After the end of this course students will be able to

CO1 Elaborate principle of remote sensing.

CO2 Illustrate active sensors for ranging and imaging.

CO3 Explore signal propagation in different sensing environment.

CO4 Analyze signal detection in noise.

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction to Sensing**	**6**
1	1.1	Introduction to Active Sensors and Passive Sensors, advantages and disadvantages of active and passive sensors	
	1.2	A brief history of sensing: Sonar, Radar, Lidar , Sensors Systems, Frequency band Allocations for electromagnetic spectrum and acoustic spectrum	
2.0		**Active Ranging Sensors**	**6**
2	2.1	Operating principle of generic time-of –flight sensor, Traingulation method: triangulation sensors as LED source, position sensitive detector, Measuring range using PSD-based sensor	
	2.2	Pulsed time-of-flight operation, Pulse range measurement, radar range equation, Acoustic range equation	
3.0		**Active Imaging Sensors**	**6**
3	3.1	Imaging techniques, Range gate limited 2-dimensional image construction	
	3.2	The Lidar range equation, Lidar system performance, Direct detection, Heterodyne Detection, Acoustic Imaging	
4.0		**Signal Propagation**	**6**
4	4.1	The sensing environment, Attenuation of electromagnetic waves: clear weather attenuation, Effect of rain, effect of fog and cloud, Overall attenuation, refraction of electromagnetic waves	
5.0		**Detection of Signals in Noise**	**6**
5	5.1	Receiver noise, Radar Noise, Noise PDF, Infrared detection and Lidar noise, Sonar Noise, Effects of SNR	
	5.2	Coherent detection, Detection of fluctuating signals	

Text Books

1. Introduction to Sensors for Ranging and Imaging, Graham Brooker, Yesdee Publication.

References

1. Fundamentals of Radar Signal Processing, Mark A. Richards, III Edition, TMG
2. Introduction to Remote sensing, J.B.Campbell, R.H.Wynne, Sixth Edition, Guilford publication.

- Internal Assessment (T1, T2 and FET):

1. T1 (Test 1) should be based on first two modules
2. Fifth module (MCQ quiz) will be assessed for 5 marks separately.

- End Semester Examination:

1. Question paper will comprise of 5 questions, each carrying 7 marks.
2. The duration of end semester examination shall be 2 hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
P71VS201		Theory	Practical	Tutorial	Theory	Practical	Tutorial

	Domain Specific Vocational Skills I- VLSI programming & Design		04	-	-	02	-

Evaluation Scheme

Course Code	Course Name	In Semester Evaluation		Semester End Exam (OE/POE)		
P71VS201	Domain Specific Vocational Skills I- VLSI programming & Design	Term work	Min pass	Marks	Min pass	Total (Marks)
		50	40%	-	-	50

Course Description: This course focuses on lab experiments on Very high speed hardware description logic (VHDL) and Verilog languages for designing Very large scale integration (VLSI) technology.

Pre-requisites: Knowledge in Digital circuit design and Microprocessors

Course Objectives:

1. To provide exposure to VLSI design.
2. To discuss VLSI design using Verilog
3. To illustrate how to apply Verilog for VLSI system design.

Course Outcomes: after the end of this course students will be able to

CO1 Design a testable digital reconfigurable system using Verilog

CO2 Outline the features and capabilities of VHDL and Verilog

CO3 Demonstrate[4] different Verilog interfacing skills.

Experiment List

- Minimum 10 to 12 experiments/programs will be performed from the following list.

Synthesis, Simulation and Implementation of

1. Half Adder & Full Adder using Dataflow (VHDL &Verilog)
2. Full Adder using Structural
3. Decoder and Encoder (VHDL & Verilog)
4. Multiplexer and De-multiplexer
5. Flip flops (D and JK) (VHDL & Verilog)
6. Universal Shift Register
7. Sequence Detector
8. Write Verilog code to realize Design of a 4 bit binary, BCD counters (Synchronous reset)
9. Write Verilog code to realize Design of a 4 bit binary, BCD counters (ASynchronous reset)
10. Schematic, Layout and Simulation of CMOS inverter NAND, NOR, XOR gate
11. Schematic, Layout and Simulation of CMOS inverter Ex-OR,Ex-NOR gate
12. Write HDL/Verilog code to control speed, direction of DC and Stepper motor.

- **Evaluation Scheme:**

1. TERM WORK assessment must be based on the overall performance of the student with every assignment graded from time to time.

2. The grades will be converted to marks as per 'credit and grading system' manual and should be added and averaged.

3. Based on above scheme grading and TERM WORK assessment should be done.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
P71PC204	Lab II- IoT Design Lab	Theory	Practical	Tutorial	Theory	Practical	Tutorial
			02	-	-	02	-

Evaluation Scheme

Course Code	Course Name	In Semester Evaluation		Semester End Exam (OE/POE)		
P71PC204	Lab II- IoT Design Lab	Term work	Min pass	Marks	Min pass	Total (Marks)
		25	40%	25	40	50

Course Description: This course focuses on the understanding of Internet of Things (IoT) systems. It also involves basic steps in design and development of Internet of Things (IoT) systems. It also covers IoT application case studies in various fields of life.

Pre-requisites: Electronics sensors and instrumentation, Electronics Communication systems.

Course Objectives:

1. Provide the most fundamental knowledge to the students so that they can understand the Internet of Things (IoT) systems.
2. Explore use cases and applications of the Internet of Things (IoT) systems.

Course Outcomes

At the end of this course students will be able to:

CO1 Analyse the components of IoT systems

CO2 Integrate and Program using IoT hardware components.

CO3 Assemble and Test Arduino and Raspberry Pi based IoT systems

Experiment List:

- Minimum 12 to 14 experiments/programs will be performed from the following list.

1. Study the fundamental of IOT softwares and components
2. Familiarization with Arduino/Raspberry Pi and perform necessary software
3. Interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
4. Interface DHT11 Humidity and Temperature Monitoring Using Arduino/Raspberry Pi
5. Intelligent Traffic Management System
6. Smart Parking System Using RFID.
7. To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.
8. Build a Cloud-based temperature Monitoring IoT system
9. Water Quality Management System using Arduino.
10. Based Baby Monitoring System Using RaspberryPi.
11. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth
12. Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to thingspeak cloud.
13. Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to Blynk Server.
14. To install MySQL database on Raspberry Pi and perform basic SQL queries.

- **Evaluation Scheme:**

1. TERM WORK assessment must be based on the overall performance of the student with every assignment graded from time to time.

2. The grades will be converted to marks as per 'credit and grading system' manual and should be added and averaged.

3. Based on above scheme grading and TERM WORK assessment should be done.

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