Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous),

Shivajinagar, Pune 5

(An Autonomous College Affiliated to SavitribaiPhule Pune University)

M.Sc. Electronic Science

Semester 3 (Second Year)

Course Type	Code	Course	Course / Paper Title	Hours / Week	Credit	Marks
Major Mandatory (4 + 4+4+2)	23ScEleP311	Major Paper 1 (Theory)	IoT based automation using Arduino and Raspberry Pi	4	4	100
	23ScEleP312	Major Paper 2 (Theory)	Digital Signal Processing	4	4	100
	23ScEleP313	Major Paper 3 (Practical)	Lab course on 23ScEleP311, 23ScEleP312 and 23ScEleP412	8	4	100
	23ScEleP314	Major Paper 4 (Theory)	Robotics and its Applications	2	2	50
Major Electives (4)	23ScEleP321	Major Elective 1 (T)	Electronic Technology in Agriculture	4	4	100
	23ScEleP322	Major Elective 2 (T)	Microwave Engineering	4		100
RP (4)	23ScEleP351	RP	Research Project I	8	4	100
Total				30	22	550

Semester 4 (Second Year)

Course Type	Code	Course	Course / Paper Title	Hours / Week	Credit	Marks
Major Mandatory (4 + 4+4+2)	23ScEleP411	Major Paper 1 (Theory)	Industry 4.0	4	4	100
	23ScEleP412	Major Paper 2 (Theory)	Process Control Systems	4	4	100
	23ScEleP413	Major Paper 3 (Theory)	E waste management	4	4	100
Major Electives (4)	23ScEleP421	Major Elective 1 (T)	Power Electronics & Renewable Energy Systems	4	4	100
	23ScEleP422	Major Elective 2 (T)	Automotive Electronics	4	4	100
RP (4)	23ScEleP451	RP	Research Project II	12	6	150
Total				28	22	550

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PG Second Year of M.Sc. Electronic Science
(2023 Course under NEP 2020)

Semester III

Course Code: 23ScEleP311

Course Name: IoT based automation using Arduino and Raspberry Pi

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA: 50 Marks **End- Sem: 50 Marks**

Prerequisite Courses:

- C Programming.
- Embedded System.
- Operating System Basics.

Course Objectives:

1. To be familiar with the Linux environment.
2. To study the Python language.
3. The ability to create systems with remote operations using the Internet.
4. To make students know the IoT ecosystem.

Course Outcomes:

On completion of the course, student will be able to

C01- Work in different IDE's.
C02- Design systems using IoT.
C03- Interface embedded hardware to Raspberry Pi.
C04- Understand Raspberry Pi and interfacing.
C05- Use Python for Electronic System development.

Course Contents:

Unit 1	**Introduction to the Internet of Things (IoT)**	**14 lectures**
	Overview, History, Definition and Characteristics, Functional blocks of IoT, IoT conceptual framework, IoT Architecture view, Sources of IoT, Connectivity Terminologies, Building blocks, Types of technologies used in IoT System, Baseline Technologies (Machine-to-Machine (M2M) communications, IoT Vs. M2M, Communication model/Technologies, Development Tools used in IoT and Protocols, Various Platforms for IoT, Examples of IoT.	
Unit 2	**IoT Hardware platforms and Interfacing**	**12 lectures**
	IoT supported Hardware platforms: Introduction to IoT Simulation Environment and Devices (Raspberry Pi, ESP, Arduino), Architecture, Setup, IDE, Installation, Interfaces (serial, SPI, I2C), basics of programming **Interfacing**: Interfacing Input, Output, Display, Sensor modules, Converters, Actuators, Controlling Hardware, Controllers and Network Devices.	
Unit 3	**Python programming**	**8 lectures**

	Need of Python program and interpreter, Variables, expressions and statements, data types, Conditional execution, Functions, Iteration, Strings, Files, Lists, Dictionaries, Tuples, Regular expressions, Networked programs, Using Web Services, Object-oriented programming, Visualizing data.	
Unit 4	**Raspberry Pi Fundamentals**	**12 lectures**
	Introduction: Raspberry Pi, Features of Raspberry Pi, History of Raspberry Pi, Full Architecture Overview, CPU Overview, CPU Pipeline Stages, Branch Prediction and Folding, Essential Input Output Devices, Setting Up Raspberry Pi, Raspbian OS, Linux commands for Raspberry Pi. Python programming on Raspberry Pi platform, patch modules of Python Raspberry Pi.	
Unit 5	**Interfacing for Arduino and Raspberry Pi**	**10 lectures**
	Interfacing: LED, SSD, Switches, Alphanumeric LCD, ADC, Servo Motor, Stepper Motor with Arduino and Raspberry Pi. Built In Functions: PWM generation, I2C, SPI, Raspberry Pi Camera. Peripheral controls through Python Interfacing different sensors to Arduino and Raspberry Pi – temperature, gas, pressure, camera, microphone, etc. Real time signal processing on Raspberry Pi.	
Unit 6	**Experiential learning: (case studies)**	**4 lectures**
	Home automation: smart lighting, smart appliances, smart parking, Intrusion Detection **Environment :**weather monitoring, Air pollution monitoring, forest fire detection ,noise pollution monitoring **Agricultural:**Smart Irrigation, greenhouse control and management, crop management, cattle monitoring. **Industrial automation:** indoor air quality monitoring, machine diagnosis and prognosis	

Text / Reference Books:

1. **Programming the Raspberry Pi Getting Started with Python,** Simon Monk, TheMcGrawHill Companies.
2. "**Internet of Things - A Hands-on Approach,"** ,Bahga, A. and Madisetti, V., (2015), Universities Press, ISBN: 9788173719547
3. **Python for Everybody,** Dr. Charles R. Severance.
4. **IoT_DIY_with-arduino_RPI_BBB**, Donald Norris.
5. **Learn RPI Programming with Python ,**WolframDonat.
6. **Internet of things -IoT** *,Raj Kamal Text Book.*
7. **"The Internet of Things: Enabling Technologies, Platforms, and Use Cases**," Auerbach Publications/CRC Press, ISBN: 9781498761284 ,Raj, P. and Raman, A. C.(2017)

MOOC / NPTEL Courses:

NPTEL Course on "**Introduction to Industry 4.0 and Industrial Internet of things**"

Prof.SudipMishra,IITKharagpur

Link of the Course: https://archive.nptel.ac.in/courses/106/105/106105195/

NPTEL Course on "**Introduction to Internet of things**"

Prof.SudipMishra,IITKharagpur

Link of the Course:https://archive.nptel.ac.in/courses/106/105/106105166/

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PG Second Year of M.Sc. Electronic Science
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Semester III

Course Code: 23ScEleP312

Course Name: Digital Signal Processing

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA: 50 Marks **End- Sem: 50 Marks**

Prerequisite Courses:

Course Objectives:

1. Understand and working knowledge of design, implementation and analysis DSP systems
2. To introduce signals, systems, time and frequency domain concepts, and DSP techniques
3. Make students aware of the meaning and implications of the properties of systems and signals.
4. To acquire the knowledge of design, implementation, analysis and comparison of digital filters for processing of discrete time signals.
5. To program DSP Processor for various applications

Course Outcomes:

On completion of the course, student will be able to–

C01- Understanding the fundamentals of discrete time signals and systems.
C02- Use concepts of trigonometry, complex algebra, Fourier transform, z-transform to analyze the operations on signals and acquire knowledge about Systems.
C03-Evaluate design problems related to frequency selective processing and design FIR/IIR filters
C04-Create a knowledge about Programmable digital signal processor.
C05-Familiar with programming environment used to developprocessor applications.
C06-Develop creative and innovative designs that achieve desired performance criteria within specified objectives and constraints, understand the need for lifelong learning.

Unit 1	**Basics of Digital Signal Processing and System**	**12 lectures**
	Characterization and classification of signals, typical signal processing operations, Examples and applications of signal processing, Analog Vs. Digital Signal Processing, Block diagram of digital signal processor, Sampling Theorem, Sampling, Quantization, Aliasing, Applications Introduction, Basic concept of signals as array of values, discrete time signals: Representation, Standard test Signals, Basic operations on discrete time signals, Discrete time System: Symbols for D-T, Interconnections for D-T systems, Properties, Causality and stability, Linear Shift Invariant (LSI) Systems: Representation, Linear convolution, Computation and properties of Linear convolution, Stability and Causality of LSI system, Correlation, A to D conversion process.	
Unit 2	**Z Transforms and analysis of Discrete time signal**	**18 lectures**

	Z-transform, Definition, region of convergence, properties of Z-transform, inverse Z transform: power series expansion method, Partial fraction expansion method, using Cauchy's residue theorem, System functions from Z transform and pole zero plot, DTFT, properties, DFT, properties, , circular convolution, graphical method and matrix method, Linear filtering using DFT , FFT. Relationship between Fourier transform and Z transform, Relationship between DFT and Z transform	
Unit 3	**Design and Realization Filters**	**18 lectures**
	Analog filters, Basics of digital filter: Types, advantages and disadvantages of digital filters, FIR Filter Structure and Design: Direct and cascade forms, frequency sampling and linear phase structure. Windowing method, Frequency sampling method of design. IIR Filter structure and Design: Direct form, Cascade form, Parallel form. Impulse invariance, Bilinear Transformation method of design.	
Unit 4	**DSP Chips and Applications**	**12 lectures**
	Introduction, types of DSP processors, architecture of DSP processor, general purpose DSP processors; Digital filter design using DSP chips, applications of DSP: audio echo cancellation, Applications of DSP in Speech, Image processing, Voice privacy, DTMF signal detection, Digital stereo FM generation, Musical sound processing.	

Course Contents:Text / Reference Books:

1) **Digital Signal Processing-Principles, Algorithms and Application,** *by John G Prokis, Manolakis, 4th Edition, Pearson Education Publication*
2) **Digital Signal Processing using MATLAB,** *by Robert J. Schilling, Sandra L.Hariris, 2nd Edition CL-Engineering , 2011*
3) **Digital Signal Processing,** *by Salivahanan, A Vallavaraj, C. Guanapriya, 1st Edition, Tata McGrawHill, New Delhi*
4) **Applied Digital Signal Processing Theory and Practice,** *by Dimitris G. Manolakis, Vinay K. Ingle, Cambridge University Press*
5) **Digital Signal Processing,** *by P. Ramesh Babu, 4th Edition, Scitech Publication.*

MOOC / NPTEL Courses:

NPTEL Course on "**Digital Signal Processing**"
Link of the Course: **https://nptel.ac.in/pPPcourses/117/102/117102060/**

NPTEL Course on "**Digital Signal Processing**"
Link of the Course: **https://nptel.ac.in/courses/108/105/108105055/**

Course: **Digital Signal Processing (DSP) and its applications**
Prof. Vikram M. Gadre ,IIT Bombay
Course Link:**https://archive.nptel.ac.in/courses/108/101/108101174/**

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Semester III

Course Code: 23ScEleP313

Course Name: lab course on 23ScEleP311, 23ScEleP312 and 23ScEleP412

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA: 50 Marks **End- Sem: 50 Marks**

Course Objectives:

The main objectives of this course are to:

1) Design and apply digital signal processing techniques to design discrete time systems and digital filter
2) Compile and solve the digital signal processing problems using MAT lab.
3) Interpret to analyze the importance of various transformation techniques in signal processing

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1) Enumerate the basic concepts of signals and systems and their interconnections in a simple and easy-to-understand manner using MATLAB
2) Design FIR and IIR filters
3) Process images using techniques of smoothing, sharpening, histogram processing, and filtering
4) Examine independently in practical laboratory and think new applications

Practical based on 23ScEleP311 (IOT based practicals) (Any 4)

1) Familiarization with Raspberry PI and perform necessary software installation.
2) To Interface LED/Buzzer with Raspberry PI
3) To interface Push Button / Digital Sensor (IR/LDR) with Raspberry PI
4) To interface analog sensor using MCP 3008 analog to digital converter chip
5) To interface DHT11 sensor with Raspberry PI and
6) To interface motor using relay with Raspberry PI
7) To interface OLED /LCD – GUI with Raspberry.
8) To interface Bluetooth/Zigbee/RFID/WiFI with Raspberry

Practical based on Arduino/ ESP 32 (Any 4)

1) To Build an Intrusion Detection System using Arduino/ESP 32
2) To Control Direction of the DC motor using Arduino/ESP32
3) To build Basic Burglar alarm security system with the help of PIR sensor and buzzer using Arduino/ESP 32
4) To interface gas sensor using Arduino/ESP 32
5) To Display humidity and temperature values on LCD using Arduino/ESP 32
6) To interface LM35 sensor using Arduino/ESP 32
7) To study smart irrigation and interface soil moisture sensor with Arduino/ESP 32 and turn ON/OFF water pump and display notification on BLYNK App.

Practical based on 23ScEleP311 (Digital Signal Processor) (Any 4)

1) Generation of signals
2) Amplitude Modulation & FFT response.
3) Impulse, Step, Exponential & Ramp functions
4) Frequency Sampling method
5) Design of FIR filter
6) Design of IIR filter
7) Image Sampling – Zooming & Shrinking operations
8) Basic Gray Level Transformations: Image negative, Power law and Log transforms
9) Image Contrast Enhancement by Histogram equalization technique.
10) Spatial Image Filtering: Low pass and High pass filtering

Practical based on 23ScEleP412 (Practical on PLC) (Any 4)

1) Introduction to Ladder Programming (any 2)
    a. Develop and simulate Logic gates and Boolean equations.
    b. Develop and Simulate Ladder program for simple on-off applications.
    c. Develop and Simulate Ladder program for timer applications.
2) Basic Ladder programming practicals (any 2)
    a. Develop and Simulate Ladder program for counter applications.
    b. Develop and Simulate Ladder program for cascading of timers & counters.
    c. Develop and Simulate Ladder program for Alarm Annunciator System
3) Ladder programming for identified applications (any 2)
    a. Develop and Simulate Ladder program for Comparison Instruction/ Logical Instruction.
    b. Develop and Simulate Ladder program for Mathematical Instruction/Special Mathematical instructions.
4) Develop and Simulate Ladder program for Data movement instructions/ Program Ladder.programming practicals (any 2)

a. Develop and Simulate Ladder program for Batch Mixer/any process application.
b. Develop and Simulate Ladder program for any process using sequencer
c. To Identify Components/sub-components of a PLC, Learning functions of different modules of a PLC system available in laboratory.

5) Develop and Simulate Ladder program for pulse counting using limit switch/proximity sensor.
6) Develop and Simulate Ladder program for bottle filling plant.
7) Develop and Simulate Ladder program for traffic light control.
8) Develop and Simulate Ladder program for Object counter - On-off control.
9) Develop and Simulate Ladder program for Car parking.
10) Develop and Simulate Ladder program for Sequential starting of motors.
11) Develop and Simulate Ladder program for automated elevator control.
12) Develop and Simulate Ladder program for tank water level control.

Practical based on Hardware circuit design (Any 4)

1) ON-OFF controller
2) Design of temperature controller using PID
3) Design and implement P / PI / PID controller
4) To study the position / velocity control of dc servo motor
5) Design lead, Lag and lead Lag compensator.
6) Study of stability of process control system.
7) Delta modulation.
8) Design PCM encoder and decoder system.
9) Design of ASK / FSK transmitter and receiver.
10) Time division Multiplexing.

Practical based on (23ScEleP314) Robotics and applications (Any 2)

1) Move Car base robot forward, backward left turn, right turn programming.
2) Line following car base robot programming.
3) Pick and place robot arm programming.
4) Remote control robotic car programming.

Practical based on Electronics & Computers in Agriculture (Any 2)

1) Measurement of soil parameters (pH, conductivity, moisture).
2) Measurement of meteorological parameters (wind speed, wind direction, temp)

3) Use of GPS software to gather data related agriculture.
4) Development of automation for green house parameters using microcontroller / PLC.
5) Development of automated drip irrigation system using microcontroller / PLC

Activity: (Any 1: Equivalent to 3 Practicals)

1. Industrial Visit (12 hrs)/Field Visit (12 hrs)/study tour (2 days)
2. Two days (12 hrs) hands-on programming workshop.
3. Seminar/presentation on advanced practical's related to respective courses.

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Semester III

Course Code: 23ScEleP314

Course Name: Robotics and it Applications

Prerequisite Courses:

- Instrumentation.
- Analog Electronics.
- Digital Electronics.
- Embedded System.

Course Objectives:

1. To study robots, mechanical actions.
2. To learn sensors, actuators, power supply.
3. Understand the working of robots.

Course Outcomes:

On completion of the course, student will be able to

C01- Design your own robots.
C02- Put self-intelligence in robots.
C03- The ability to integrate mechanical systems, electronic systems and computer systems.

Course Contents:

Unit1	**Basics of Robotics**	**10 lectures**
	History, Present status and future trends in Robotics and automation, Laws of Robotics, Robot definitions, Robot generations, Robotics system components, Robot anatomy, Specification of Robots - resolution, repeatability and accuracy of a manipulator. Robotics applications. Locomotion: Introduction, Key issues for locomotion, Legged Mobile Robots, Leg configurations and stability, Examples of legged robot locomotion, Wheeled Mobile Robots, Wheeled locomotion: the design space, Wheeled locomotion :case studies.	
Unit 2	**Robot Kinematics**	**10 lectures**
	Mobile Robot Kinematics: Kinematic Models and Constraints: Representing robot position, Forward kinematic models, Wheel kinematic constraints, Robot kinematic constraints, Examples: robot kinematic models and constraints, Mobile Robot Maneuverability: Degree of mobility, Degree of steer ability, Robot maneuverability. Mobile Robot Workspace: Degrees of freedom, Holonomic robots, Path and Trajectory considerations, Beyond Basic Kinematics Motion Control (Kinematic Control):Open loop control(trajectory following),Feedback control	
Unit 3	**Robot Applications**	**10 lectures**
	Industrial Application of Robot: Application of Robots in continuous arc welding, Spot welding, Spray painting, assembly operation, cleaning, robot	

	for underwater applications. **Agriculture application:** Application of Robots in ploughing, seeding, Crop Monitoring and Analysis, Fertilizing and Irrigation, Thinning and Pruning, Picking and Harvesting, Shepherding and Herding, Milking etc	

Text/Reference Books:

- **Robot Dynamics and Control,** *Spong and M.Vidyasagar,Wiley Student Edition*
- **Robotics: Fundamental Concepts and Analysis,** *AshitavaGhoshal, Oxford Higher Education*
- **Robotic Engineering: An integrated approach,** *Richard D.Klafter, Thomas A. Chmielewski and Michael Negin, Prentice-Hall India*
- **Modern Robotics Mechanics, Planning And Control,** *Kevin M. LynchandFrankC.Park*
- **"Introduction to Robotics in CIM Systems"** James A Rehg, Prentice Hall of India, 2002.
- **S K Saha, "Introduction to Robotics**, 2nd edition, TMH, 2013.
- **Mechatronics,**W.Bolton, 4th Edition, Pearson.

MOOC / NPTEL Courses:

NPTEL Course on "**Advanced Robotics**"

by Prof .Ashish Dutta, IIT Kanpur

Link of the Course: https://archive.nptel.ac.in/courses/112/104/112104316/

NPTEL Course on "**Introduction to Robotics**"

by Prof .Ashish Dutta, IIT Kanpur

Link of the Course:https://archive.nptel.ac.in/courses/112/104/112104298/

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Semester III

Course Code: 23ScEleP321

Course Name: Electronic Technology in Agriculture

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA: 50 Marks **End- Sem: 50 Marks**

Prerequisite Courses:

- Sensors and actuators.
- Basics of Agricultural activities.
- Instrumentation system.
- Internet of Things

Course Objectives:

1. To inculcate the ability to understand variousproblems in Farming and to provide appropriate technology based solutions to the agricultural sector.
2. An overview of technology of advanced topics like Smart farming, Precision farming, use of AI& ML.
3. The enhance the ability to select the essential elements and practices needed to develop and implement the Technological advancements for the agricultural sector.

Course Outcomes:

On completion of the course, student will be able to–

C01- Understand Role of Electronics Technology in Agriculture Sector
C02-Analyze and suggest appropriate Instrumentation for different agricultural processes
C03- Understand the use of advanced technologies in Smart Agriculture.
C04- Apply knowledge of Electronics technology (IoT) in Agriculture.
C05- Understand the use of Ai and ML in Agriculture 4.0.

Unit 1	Instrumentation for Agriculture	15 lectures
	Introduction to various processes in farming, Instrument for measurement of pH, Electrical conductivity, gas analysis, humidity, leaf area, chlorophyll content, and soil moisture & temperature. **Instruments in Agriculture:** Instrument for crop monitoring – moisture measurement – capacitive, infrared reflectance and resistance. Monitoring soil and weather – measurement of soil properties and meteorological parameters – irrigation control systems. Instruments for crop establishment monitoring. Crop spraying – selective crop spraying – flow control. Yield monitoring.	

	Technology for precision farming: Instruments for protected cultivation – Poly-house environment control – transducers and control system. Instruments and systems for crop handling processing and storage.	
Unit 2	**Introduction to Smart Agriculture**	**15 lectures**
	What is Smart Agriculture? , The trend in smart agriculture paradigm, Advantages and disadvantages of Smart Agriculture, Role of Smart Agriculture in Soil Preparation(Sensors: Temperature, Moisture, NPK etc), Vertical Farming : Hydroponic systems ,aeroponic systems, Aquaponic systems (block diagrams and explanation)	
Unit 3	**Smart Farming using Internet of Things (IoT)**	**15 lectures**
	Concept of IoT ,Role of IoT in Smart agriculture , WSN with Agricultural field, Tools used by IoT in smart farming, Precision Agriculture(PA) , Types of Sensors in Precision Agriculture, Requirements of PA, Role of Irrigation in Smart Agriculture , Robotics in agriculture ,Drones in agriculture,Remote sensing sensors in agriculture, Challenges of PA in Smart Agriculture,Agro-IoT Sensor Network, International standards support for Agro- IoT Communication : block diagram of Sensor module, overview of standards and protocols in IoT based communication network, communication Technology for Agro-IoT, Comprehensive overview of communication Protocols.	
Unit 4	**Machine Learning Approaches for Agro-IoT Systems and Agriculture 4.0**	**15 lectures**
	Need of ML in IoT, Role of IoT Data in ML based Agro-IoT system, Steps of Machine learning process in Smart Agriculture, Machine Learning models used in Agriculture application, Concept of Unsupervised learning, Applications on ML Agro-IoT system.	

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Agriculture 4.0 : What is Agriculture 4.0? Elements of Agriculture 4.0, Emerging technologies in PA: Remote sensing , Drones, Machine Learning, Artificial Intelligence driven automation, Concept of Software-as-a-Service (SaaS)

Text / Reference Books:

•**Cloud IoT Systems for Smart Agricultural Engineering** by Sarvanan Krishnan, J Bruce Ralphin Rose, N R Rajlakshmi, Narayanan Prasanth, CRC Press (Taylor & Francis Group)

- **Agriculture 4.0 : The Future of farming Technology** , By Matthieu De Clercq, Anshu Vats, Alvaro Biel (https://www.oliverwyman.com/content/dam/oliver-wyman/v2/publications/2021/apr/agriculture-4-0-the-future-of-farming-technology.pdf)
- Agriculture 4.0 - the Future of farming Technology, by Dolores Parras-Burgos, Martinez, G.G. Mateos (https://mdpi-res.com/bookfiles/book/8467/Agriculture_40__The_Future_of_Farming_Technology.pdf?v=1710859547)
- https://www.researchgate.net/publication/364311718_Agriculture_40

- **Internet of Things and Analytics for Agriculture,** *by Prasant Kumar Pattnaik, Raghvendra Kumar, Souvik Pal Volume 1 & 2" Springer*

•**Smart Agriculture: An Approach Towards Better Agriculture Management,** *by Dr. Aqeel – ur –Rehman, OMICS International*

•**Satellite Farming: An Information and Technology Based Agriculture,** *by Latief Ahmad, Syed Sheraz Mahdi, Springer International Publishing 2018.*

•**Advances in Agricultural Machinery and Technologies,** *by Uangnan Chen, CRC Press.*

•**Agricultural Internet of Things and Decision Support for Precision Smart Farming,** *by AnnamariaCastrignanò, Gabriele Buttafuoco, Raj Khosla, Abdul M. Mouazen, Academic Press*
•**Agricultural Automation Fundamentals and Practices, by Qin Zhang and Francis J. Pierce, CRC Press**

https://inc42.com/resources/agriculture-4-0-how-new-age-tech-is-shaping-the-future/
https://www.getac.com/intl/blog/future-of-farming/

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Semester III

Course Code: 23ScEleP322

Course Name: Microwave Engineering (Elective course)

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA: 50 Marks **End- Sem: 50 Marks**

Course objective:

1. To analysis the microwave circuits and systems
2. Understand the concepts of Microwaves, Microwave Amplifiers and Oscillators.

Course outcome:

On completion of the course, student will be able to–

C01- Understand various microwave system components and their properties.
C02- Applying microwave devices used to realized amplifiers and oscillators
C03- Analyze performance of microwave components from field point of view
C04- To understand the applications of microwave engineering.

Course Contents:

Unit 1	**Fundamentals of microwaves**	**15 lectures**
	History of microwave, microwave frequency band, applications of microwave, microwaves tube and field devices: Klystrons – Two cavity klystrons – Multicavity klystrons – Reflex klystrons – Power output and frequency characteristics – Efficiency of reflex klystron – Traveling wave tube (TWT) – Applications of TWT – Backward wave oscillator Magnetron – Cavity magnetron – Sustained oscillation in magnetron – Characteristics and applications of magnetron.	
Unit 2	**Microwave components:**	**15 lectures**
	Rectangular and Circular cavity Resonators, Microwave Hybrid Circuits - Waveguide Tees E-plane or Series tee, H-plane or shunt Tee, Magic Tees(Hybrid Tees), Applications of magic Tee, Hybrid Rings (Rat-Race Circuits) Hybrid Rings, Waveguide Corners, Bends and Twists, Directional Couplers, Two-Hole Directional Couplers, S Matrix of a Directional Coupler, Circulators and Isolators.	
Unit 3	**Microwave measurements**	**10 lectures**
	Description of Microwave Bench: Different Blocks and their Features, Precautions; Microwave Power Measurement: Bolometer Method. Measurement of Attenuation, Frequency, VSWR. Impedance Measurement. Network analyzer	
Unit 4	**Microwave applications (case studies)**	**15 lectures**
	Wireless communication system, RADAR, Radiometer system, satellite	

	communication, Remote sensing.	

Text / Reference Books:

1) **Microwave Devices and Circuits**, Samuel Y. Liao, ,Pearson education, 3rd Edition, 2007
2) **Microwave Engineering**, Pozar, Wiley publishers, 4th Edition, 2012
3) **Foundations for Microwave Engineering**, R.E. Collin, IEEE Press, John Wiley, 2nd Edition,
4) **Microwave & Radar Engineering**, GottapuSasibhushana Rao, Pearson Education, 2013

MOOC / NPTEL Courses:

Microwave Engineering byPpro. Girish Kumar, IIT Bombay
Link for course: https://archive.nptel.ac.in/courses/108/101/108101112/

Microwave Engineering by Prof. RatnajitBhattacharjee , IIT Guwahati
Link for course: https://archive.nptel.ac.in/courses/108/103/108103141/

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Semester III

Course Code: 23ScEleP351

Course Name: Research project I

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA: 50 Marks **End- Sem: 50 Marks**

Course Objectives:

1) To understand the product Development Process‟ including budgeting through Project/ Research project.
2) To plan for various activities of the project and distribute the work amongst team members.
3) To inculcate electronic hardware implementation skills by -
    a. Learning PCB artwork design using an appropriate EDA tool.
    b. Imbibing good solde ring and effective trouble-shooting practices.
4) To develop student‟s abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Mini Project.
5) To understand the importance of document design by compiling Technical Report on the Project /Research work carried out.

Course Outcome:

On completion of the course, student will be able to

1) Understand, plan and execute a Research projects/ Industrial project /Project in individual or with team.
2) Implement electronic hardware by learning PCB artwork design, soldering techniques, testing and troubleshooting etc.
3) Prepare a technical report based on the Research projects/ Industrial project /Project
4) Deliver technical seminar based on the Research projects/ Industrial project /Project work carried out.

A) Execution of Research projects/ Industrial project /Project

- The project can be undertaken in house or in an industry or in a research/ service organization.
- Project can select by individual student.
- Project group shall consist of **not more than 2** students per group.
- Research projects/ Industrial project /Project work should be carried out in the Design / Projects Laboratory.
- Project designs ideas can be necessarily adapted from recent issues of electronic design magazines Application notes from well known device manufacturers may also be referred.
- Use of Hardware devices/components is mandatory.
- Layout versus schematic verification is mandatory.
- Bare board test report shall be generated.
- Assembly of components and enclosure design is mandatory.

B) Selection: Domains for Research projects/ Industrial project /Project may be from the following, but not limited to:

a) Instrumentation and Control Systems
b) Electronic Communication Systems
c) Biomedical Electronics
d) Power Electronics

e) Audio , Video Systems
f) Embedded Systems
g) Mechatronic Systems
h) Microcontroller based projects should preferably use Microchip PIC controllers / ATmega controller / AVR microcontrollers / Ardino / Rasberry Pi.
i) Material science

C) **Monitoring: (for students and teachers both):** Suggested Plan for various activities to be monitored by the teacher.
Week 1 & 2: Formation of groups, Finalization of research project/ Project & Distribution of work.
Week 3 & 4: PCB artwork design using an appropriate EDA tool, Simulation.
Week 5 to 8: PCB manufacturing through vendor/at lab, Hardware assembly, programming (if required) Testing, Enclosure Design, Fabrication etc
Week 9 & 10: Testing of final product, Preparation, Checking & Correcting of the Draft Copy of Report
Week 11 & 12: Demonstration and Group presentations.
Log book for all these activities shall be maintained and shall be produced at the time of examination.

D. Report writing: A project report with following contents shall be prepared:

- Title
- Specifications
- Block Diagram
- Circuit Diagram
- Selection of components, calculations
- Simulation Results
- PCB Art work
- Testing Procedures
- Enclosure Design
- Test Results & Conclusion
- References
- Project report contain header of project title and footer with name of student

CIE Evaluation shall be done with marks distribution as follows:

• Selection of the topic & formulation of objectives	10%
• Design and simulation/ algorithm development/experimental setup	25%
• Conducting experiments / implementation / testing / analysis	25%
• Demonstration & Presentation	20%
• Report writing	20%

End Semester Evaluation (ESE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization.

The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

The guidelines of the assessment of the project for end-semester examination are as follows

Sr. No.	Performance Criteria	Max %	Rating (%)				
			Excellent	Very Good	Good	Fair	Poor
1	Selection of Project	10	10	08	06	04	02
2	Planning & Implementation	10	10	08	06	04	02
3	Quality of Performance	20	20	16	12	08	04
4	Regularity of Work carried	10	10	08	06	04	02
5	Report Writing Skills	10	10	08	06	04	02
6	Self Expression, Communication Skill and Presentation	10	10	08	06	04	02
7	Viva-Voce	20	20	16	12	08	04
8	Project idea present in research Journal	10	10	08	06	04	02
Total		**100**	**100**	**80**	**60**	**40**	**20**

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PG Second Year of M.Sc. Electronic Science
(2023 Course under NEP 2020)

Semester IV

Course Code: 23ScEleP411

Course Name: Industry 4.0

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA: 50 Marks **End- Sem: 50 Marks**

Prerequisite Courses:

1. Concept of Automation (Hardware & Software)
2. Basic knowledge of IoT
3. Basic communication Protocol role and functions

Course Objectives

1. To impart basic idea in Industry 4.0
2. To provide students with good depth of knowledge of designing Industrial 4.0 Systems for various application.
3. Learn the design and analysis of Industry 4.0 system Communication Protocols.

Course Outcomes

On completion of the course, student will be able to

CO1 - Understand the basic concepts of Industry 4.0 and the other related fields.
CO2 – Understand role of Automation in Industry
CO3 – Understand the Communication Protocols in Industry 4.0
CO4 - Analyze a cyber-physical system and the emerging applications

Course Contents

Unit 1	**Introduction to Industry 4.0**	**15 lectures**
	The Industrial Revolution, Introduction to Industry 4.0, Components of Industry 4.0,Characteristics of Industry 4.0, LEAN manufacturing, Smart and connected business perspectives, Smart factories ,Dissemination of Industry 4.0, Artificial intelligence, The Internet of Things and Industrial Internet of Things, Additive manufacturing, Robotization and automation, Current situation of Industry 4.0.	
Unit 2	**Industrial Automation**	**12 lectures**
	Overview of Programmable Logic Controller (PLC) and its Programming software, Communication of different devices with PLC, Sensors, Smart Sensor, HMI design, Introduction to Industrial Robot, Additive manufacturing (AM), Augmented and virtual reality (AR/VR), Big Data & Cloud computing, Agile Manufacturing.	
Unit 3	**Industry 4.0 and Cyber Physical System**	**15 lectures**
	Introduction to Cyber Physical Systems (CPS), Architecture of CPS-Components, ISA-95 architecture, CPS-5C architecture, Data science and technology for CPS, Emerging applications in CPS in different fields,	

	Concept of Digit Twin. **Communication Protocols –** MQTT, OPC UA, EtherNet/IP, Profinet, EtherCAT, etc.MQTT – History, MQTT broker, Message types, Quality of Service (QoS), Application; OPC UA – History, Specification, Client, Server, Programming with – Free and open-source software, Propriety software; Augmented Reality.	
Unit 4	**IOT Platform**	**14 lectures**
	Data Modelling, IoT platforms – Thing, basic functionalities, Abstract definition of Thing, Networks, etc; IoT Gateway, Machine interfaces – Cloud-based Mosquitto brokers, Programming with – Free and open-source software, Propriety software. Machine Learning Foundation Learning algorithms – Supervised, Unsupervised, Self-learning, Feature learning, etc. Models – Artificial Neural Networks, Decision trees, Regression analysis, Genetic algorithms, etc.; Programming with – Free and open-source software, Propriety software.	
Unit 5	**Case Studies**	**4 lectures**
	Any Two case studies from: Healthcare Industry, Automobile Industry	

Reference

1. W. Botton, “Programmable Logic Controllers”, Fourth Edition, Elsevier, 2006
2. Jean-Claude André, ―Industry 4.0‖, Wiley- ISTE, July 2019, ISBN: 781786304827,2019.
3. Diego GalarPascual, Pasquale Daponte, Uday Kumar, ―Handbook of Industry 4.0 and SMART Systems‖ Taylor and Francis,2020
4. Miller M, ―The internet of things: How smart TVs, smart cars, smart homes, and smart cities are changing the world‖, Pearson Education, 2015, ISBN: 9780134021300.
5. Christoph Jan Bartodziej, “The Concept Industry 4.0 – An Empirical Analysis of Technologies and Application in Production Logistics”, SpingerGabler, 2015
6. Alasdair Gilchrist, “Industry 4.0 – The Industrial Internet of Things”, Springer Link, 2016
7. Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications”, ISBN: 978-1-118-47347-4, Willy Publications.
8. Michahelles, “Architecting the Internet of Things”, ISBN 978-3- 642-19156-5 e-ISBN 978-3-642-19157-2, Springer.
9. HakimaChaouchi, “The Internet of Things Connecting Objects to the Web” ISBN : 978-1-84821-140-7, Willy Publications.
10. Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things: Key Applications and Protocols”, ISBN: 978-1-119-99435-0, 2nd Edition, Willy Publications
11. W. Botton, “Programmable Logic Controllers”, Fourth Edition, Elsevier, 2006
12. P. Juahs, K. Molnar, “Key Components of the Architecture of Cyber-physical manufacturing systems”, International Scientific Journal “Industry 4.0”, 2017, issue 5, 205- 207
13. Jen-Ruey Jiang, “An improved cyber-physical systems architecture for Industry 4.0 smart factories”, Advances in Mechanical Engineering, 2018, Vol. 10(6) 1-15
14. http://www.mqtt.org 11. https://opcfoundation.org/about/opc-technologies/opc-ua/
15. https://www.researchgate.net/publication/332440369_An_Overview_of_Industry_40_Definition_Components_and_Government_Initiatives
16. https://mrcet.com/downloads/digital_notes/ME/III%20year/Smart%20Manufacturing%20Technologies.pdf

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PG Second Year of M.Sc. Electronic Science
(2023 Course under NEP 2020)

Semester IV

Course Code: 23ScEleP412

Course Name: Process Control Systems

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA: 50 Marks **End- Sem: 50 Marks**

Prerequisite Courses:

1. Basic Analog/Digital Electronics
2. Practical significance of Mathematics, Algebra, Differential Calculus.

Course Objectives:

1. To study the open loop and closed loop (feedback) systems
2. To learn the mathematical analysis of control systems.
3. To understand the analysis of signals in time domain and frequency domain.
4. To understand time domain and frequency domain analysis of control systems required for stability analysis.
5. To study working principles and applications of programmable logic controller.

Course Outcomes:

On completion of the course, student will be able to–

C01- To understand the standard specifications of various transducers and select them for a given application.

C02- Have knowledge of open loop and closed loop control systems.

C03- Able to analyze the control system by various mathematical theorems.

C04- Able to analyze the signal in time domain and frequency domain.

C05- Analyze the principle and working of continuous and discontinuous controller modes.

C06- Design analog controllers based on op-amps systems.

C07- Develop the PLC programs in IEC 61131-3 PLC languages for process control applications.

Course Contents

Unit 1	**Basics of Control System**	**10 lectures**
	Closed loop control and functional elements in it open-loop control, continuous and discrete state control, control strategies such as feedback, feed forward and adaptive control. Control system examples: Speed control system, position control system, temperature and level control systems, reel drives, tension control system for paper.	
Unit 2	**Control System Analysis**	**20 lectures**

	S-plane, Poles and Zeros of Function, Differential Equations-Examples, concept of transfer function and its use, method of obtaining transfer function, block diagram of control system, rules of block diagram reductions and example. Signal Flow Graphs, Basic Elements, Basic Properties, Definition of Terms, Gain Formulas, Concept of stability, Routh stability criterion, Roth-Hurwitz criterion, Root locus steps in drawing root locus, Use of root locus and examples thereof. Frequency response methods of control system analysis, Bode plots method to plot and examples thereof, Nyquist plots, method to plot and examples thereof, process loop tuning and control system evaluation, Open loop transient response method, Zeigler- Nichols method	
Unit 3	**Analog Controllers**	**14 lectures**
	Classification of controllers, Discontinuous controllers: On-OFF Controller, three position controller. Continuous controllers: Proportional, Integral and Derivative control. Composite control modes: PI, PD and PID controllers. Derivative overrun and integral windup in PID control mode Design of analog controller circuits for above modes characteristics. PID controller tuning techniques.	
Unit 4	Programmable logic Controller	**6 lectures**
	Types of I/Os- Discrete, Digital, and Analog, functional diagram, operation, programming. PLC system types, I/O modules and interfacing, CPU processor, programming devices, programming formats, construction of physical ladder diagrams. I/O wiring, HMI, Introduction to IEC 61131-3 standard programming languages like LD, FBD, SFC, ST and IL. PLC Programming. Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram construction and flow chart for process control applications.	
Unit 5	**DCS and SCADA**	**10 lectures**
	Direct digital control systems, distributed control systems (DCS): Introduction, DCS flow sheet symbols, architecture of DCS controller, DCS communication, DCS supervisory computer tasks, Features and advantages of DCS. Supervisory control and Data acquisition (SCADA): SCADA introduction, elements of SCADA, Features of SCADA, and MTU- functions of MTU, RTU Functions of RTU, and Applications of SCADA.	

Text / Reference Books:

1) **Process control instrumentation technology,** *C. D Johanson, PHI.*
2) **Control Systems,** *U.A. Bakshi and V. U. Bakshi, Technical Publications Pune.*
3) **Modern Control engineering,** *Ogata, Prentice Hall, EEE*
4) **Control Systems Engineering,** *S. Salivahanan, R. Rengaraj and G. R. Venkatakrishnan, Pearson*
5) **Programmable Logic Controllers Principles and Applications,** *John W. Webb and Ronald A. Reis, Fifth Edition, Prentice Hall Publication, New Delhi, 2002.*
6) **Programmable Logic Controllers,***W.Bolton, Fifth Edition, Elsevier Publication*
7) **Programmable Logic Controllers,** *Frank D. Petruzella, Third Edition, Tata McGraw Hill Education Private Limited, 2010.*

MOOC / NPTEL Courses:

NPTL course on: Control Systems,

Prof. C.S. Shankar Ram, IIT Madras

Course Link: https://archive.nptel.ac.in/courses/107/106/107106081/#

NPTL course on: Control Engineering,

Prof. Ramkrishna Pasumarthy , IIT Madras

Course Link: https://archive.nptel.ac.in/courses/108/106/108106098/

NPTL course on: Industrial Automation and Control,

Prof. S. Mukhopadhyay, Prof. S. Sen, IIT Kharagpur

Course Link: https://nptel.ac.in/courses/108105063 (For PLC lecture)

Course Link: https://archive.nptel.ac.in/courses/108/105/108105062/ (For Sensor Actuator + PID tuning)

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PG Second Year of M.Sc. Electronic Science
(2023 Course under NEP 2020)

Semester IV

Course Code: 23ScEleP413

Course Name: E-Waste Management

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA: 50 Marks **End- Sem: 50 Marks**

Prerequisite Courses:

Environmental Sciences, Introduction to Environmental Engineering, Basic knowledge of electrical / electronic equipment.

Course Objectives:

1. Develop the ability to identify different types of E-wastes.
2. Know the various techniques of E-waste disposal.
3. Understand the Environmentally Sound E-Waste Management.

Course Outcomes Upon successful completion of the course, the student will be able to

C01- Know about the environmental impacts of e-waste.

C02- Apply various concepts learned under e-waste management hierarchy.

C03- Distinguished the role of various national and internal act and laws applicable for e-waste management and handling.

C04- Analyze the e – waste management measures proposed under national legislations.

Course Contents:

Unit 1	**Introduction to e-waste management**	**10 lectures**
	Definition of e-Waste, What is e-Waste, Indian and global scenario of e-Waste, Growth of Electrical and Electronics industry in India, e-waste generation in India, Composition of e-waste, Possible hazardous substances present in e-waste, Environmental and Health implications.e- waste; composition and generation. Global context in e- waste; e-waste pollutants, e waste hazardous properties, Effects of pollutant (e- waste) on human health and surrounding environment, domestic e-waste disposal,	
Unit 2	**End of life management of e-waste**	**08 lectures**
	Historic methods of waste disposal – dumping, burning, landfill;Recycling and recovery technologies – sorting, crushing, separation; Life cycle assessment of a product – introduction; Case study – optimal planning for computer waste.	
Unit 3	**E-waste control measures**	**10 lectures**
	Need for stringent health safeguards and environmental protection laws in India, Extended Producers Responsibility (EPR), Import of e-waste permissions, Producer-Public-Government cooperation, Administrative Controls & Engineering controls, monitoring of compliance of Rules, Effective regulatory mechanism strengthened by manpower and technical expertise, Reduction of waste at source.	

Unit 4	**E-waste legislation**	**15 lectures**
	Regulatory regime for e-waste in India, The hazardous waste(Management and Handling) rules 2003, Ewaste management rules 2015, Regulatory compliance including roles and responsibility of different stakeholders – producer, manufacturer, consumer etc., Proposed reduction in the use of hazardous substances(RoHS), Extended producer responsibility (EPR).E-waste (Management and Handling) Rules, 2011; and E-Waste (Management) Rules, 2016 - Salient Features and its likely implication. Government assistance for TSDFs.	
Unit 5	**Environmentally e-waste management**	**15 lectures**
	Basic principles of E waste management, Component of E waste management, Emerging recycling and recovery technologies, Guidelines for environmentally sound management of e-waste, Technologies for recovery of resources from electronic waste, resource recovery potential of e-waste, steps in recycling and recovery of materials-mechanical processing, technologies for recovery of materials, occupational and environmental health perspectives of recycling e-waste in India. Environmentally sound treatment technology for e-waste, Guidelines for establishment of integrated e-waste recycling and treatment facility, Case studies and unique initiatives from around the world.	

Text / Reference Books:

(1) "E-waste: implications, regulations, and management in India and current global best practices", Johri R., TERI Press, New Delhi.
(2) Electronic Waste – 1st Edition (Toxicology and Public Health Issues), Fowler B. 2017Elsevier
(3) 2. Electronic Waste Management. Science ,Hester R.E., and Harrison R.M. 2009

MOOC / NPTEL Courses:
Electronic Waste Management - Issues and Challenges, IIT Kharagpur
Prof. Brajesh Kumar Dubey
Link for course: https://nptel.ac.in/courses/105105169

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PG Second Year of M.Sc. Electronic Science
(2023 Course under NEP 2020)

Semester IV

Course Code: 23ScEleP421 (Elective)

Course Name: Power Electronics and renewable energy system

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA: 50 Marks **End- Sem: 50 Marks**

Prerequisite Courses:

Basic knowledge of heat transfer, thermodynamics and fundamentals of physics.

Course objective:

1. To understand the different types if solar PV cells and its electrical characteristics.
2. To examine the operation of grid connected off-grid and hybrid solar PV systems.
3. To design a practical PV system through the understanding of module connections, inverter selection and sizing.

Course outcome:

On completion of the course, student will be able to–

C01-Analyse the performance of different types of solar PV cells based on its electrical characteristics.

C02-Design grid connected off-grid and hybrid solar PV systems based on the requirements.

Course Contents:

Unit 1	**Renewable energy system**	**10 lectures**
	Introduction of Renewable energy system, Types, merits and demerits, mechanism of energy storage, block diagram of system. government subsidies Schemes for Renewable energy.	
Unit2	**Types of Solar Power Plant**	
	Grid Connected solar Power Plant, Grid interactive solar power plant, Net Metering Solar Power Plant Off-Grid /Hybrid solar power plant, Schemes of solar power plant.	
Unit 3	**Selection of PV module technology and PV module characteristics**	**15lectures**
	Introduction, Crystalline technology, thin film technology, Bi-facial technology, Comparison between PV module technologies, Comparison between solar power plant energy output. Characteristics of a Solar Cell, Power Characteristics of a Solar Cell, Fill factor and Equivalent Solar cell Circuit, STC and NOCT, I-V under partial shading.	
Unit 4	**Inverters Selection and Sizing**	**10 lectures**
	Types of solar inverter, Selection of string /central / off grid inverter, Selection of power conditioning unit (PCU), Sizing of solar inverter for roof top and grid connected projects, Selection and sizing of string inverter, Selection and sizing of central inverter.	
Unit 5	**Connection of PV Module (Series and Parallel)**	**15lectures**

	Series Circuits, Parallel Circuits, Combining Series & Parallel Circuits, PV module string connection, Matching the PV Array to The Voltage Specifications of An Inverter Matching the PV-Array to the Inverter's Current Rating, Matching the PV-Array to the Inverter's Power Rating, Summary of Calculations for Matching Array and Inverter.	

Text / Reference Books:

1) Renewable and Efficient Electric Power Systems, Gilbert M. Masters, John Wiley & Sons, 2004
2) Photovoltaic Systems Engineering, Roger A. Messenger & Jerry Ventre CRC Press, 2004

MOOC / NPTEL Courses:

Course: Solar energy engineering and technology, PROF. PANKAJ KALITA, Department of Energy Science and Engineering , IIT Guwahati
Course link: https://archive.nptel.ac.in/courses/115/103/115103123/

Course: solar photovoltaics fundamentals, technology and applications
Prof. SoumitraSatapathi, Department of Physics IIT Roorkee
Course link: https://archive.nptel.ac.in/courses/115/107/115107116/

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PG Second Year of M.Sc. Electronic Science
(2023 Course under NEP 2020)

Semester IV

Course Code: 23ScEleP422 (Elective)

Course Name: Automotive Electronics

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA: 50 Marks **End- Sem: 50 Marks**

Prerequisite Courses:

- Analog Electronics.
- Instrumentation.
- Embedded System.

Course Objectives:

1. To understand the concepts of Automotive Electronics and its evolution and trends.
2. Automotive systems & subsystems overview.
3. To understand sensors and sensor monitoring mechanisms aligned to automotive systems, different signal conditioning techniques, interfacing techniques and actuator mechanisms.
4. To describe various communication systems, wired and wireless protocols used in vehicle networking.
5. To understand Safety standards, advances towards autonomous vehicles.

Course Outcomes:

On completion of the course, student will be able to–

C01- Obtain an overview of automotive components, subsystems, design cycles, communication protocols and safety systems employed in today's automotive industry.

C02- Interface automotive sensors and actuators with microcontrollers.

C03- Develop, simulate and integrate control algorithms for ECUs with hardware.

Course Contents:

Unit 1	Automotive Industry Overview	15lectures
	Overview of Automotive Industry: Leading players, Automotive supply chain, Global challenges, Role of technology in Automotive Electronic and interdisciplinary design, Tools and processes. Introduction to Modern Automotive Systems and need for electronics in automobiles and application areas of electronic systems in modern automobiles. Spark and Compression Ignition Engines: Ignition systems, Fuel delivery systems, Engine control functions, Fuel control, Electronic systems in engines. Vehicle Braking Fundamentals: Vehicle dynamics during braking, Hydraulic brake system components, Introduction to anti lock braking systems. Steering Control: Steering system basics, Fundamentals of electronically controlled power steering, electronically controlled hydraulic systems and electric power steering systems,	

	Passenger safety and convenience, Occupant protection systems, tyre pressure monitoring systems. Active Safety Systems: ABS, TCS, ESP, Brake assist, etc. Passive Safety Systems: Airbag systems.	
Unit 2	**Sensors, Actuators and Communication Protocols**	**15lectures**
	Sensors: Accelerometers, Wheel speed, Brake pressure, Seat occupancy, Engine speed, Steering wheel angle, Vehicle speed, Throttle position, Turbine speed, Temperature, Mass air flow (MAF) rate, Exhaust gas oxygen concentration, Throttle plate angular position, Crankshaft angular position/RPM, Manifold Absolute Pressure (MAP), Differential exhaust gas pressure and Air bag sensors. **Actuators**: Relays, Solenoids and motors. Chassis control systems and Automatic transmission control systems. **Communication protocols**: Overview of automotive communication protocols, CAN, LIN, j1939, Flex Ray, MOST, D2B and DSI,Communication interface with ECUs, Interfacing techniques and Interfacing with infotainment gadgets, Relevance of Protocols such as TCP/IP for automotive applications, Wireless LAN standards such as Bluetooth, IEEE 802.11x communication protocols for automotive applications. Infotainment Systems: Application of telematics in automotive domain, Global positioning systems (GPS) and General packet radio service (GPRS).	
Unit 3	**Automotive Control Systems and Model Based Development**	**15lectures**
	Automotive Control System & Model Based Development: Control system approach in Automotive Electronics, Analog and digital control methods,Modeling of linear systems, System responses, Modeling of Automotive Systems with simple examples. Model based Development: Introduction to MATLAB, Simulink and SIMSCAPE tool boxes, Model-Based Design for a small system, Motor Model, Generator Model, Controller Model, SimDriveline, Introduction to Simulink simulations, Exploring the system response using different control methods, Tuning the system, Exploring system limitations, Understanding and refining motor models, Real time simulations on a simple target (Arduino / Raspberry Pi etc), Study of modeling and simulation of any one Automotive System.	
Unit 4	**Electrical Mobility in Automobiles and Diagnostic Systems**	**15lectures**
	Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drivetrain topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of PermanentMagnetMotor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency. Advanced Driver Assistance Systems (ADAS): Combining computer vision techniques as pattern recognition, feature extraction, learning, tracking, 3Dvision, etc. Examples of Assistance Applications: Lane Departure Warning, Collision Warning, Automatic Cruise Control, Pedestrian Protection, Headlights Control, Connected Cars technology and trends towards Autonomous vehicles.	

Text / Reference Books:

1) **Automotive Electronics Handbook,** *by Ronald K Jurgen, 2nd Edition, McGraw-Hill, 1999.*

2) **Automotive Electricity and Electronics,** *by James D. Halderman, PHI Publication.*

3) **Automotive Computer Controlled Systems, Diagnostic Tools and Techniques,** *by AllanBonnick, Elsevier Science, 2001.*

4) **Automotive Electronics Handbook,** *by URobert Bosch, John Wiley and Sons, 2004*

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PG Second Year of M.Sc. Electronic Science
(2023 Course under NEP 2020)

Semester IV

Course Code: 23ScEleP451

Course Name: Research project

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA: 50 Marks **End- Sem: 50 Marks**

Course Objectives:

6) To understand the product Development Process‟ including budgeting through Project/ Research project.
7) To plan for various activities of the project and distribute the work amongst team members.
8) To inculcate electronic hardware implementation skills by -
    c. Learning PCB artwork design using an appropriate EDA tool.
    d. Imbibing good solde ring and effective trouble-shooting practices.
9) To develop student‘s abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Mini Project.
10) To understand the importance of document design by compiling Technical Report on the Project /Research work carried out.

Course Outcome:

On completion of the course, student will be able to

5) Understand, plan and execute a Research projects/ Industrial project /Project in individual or with team.
6) Implement electronic hardware by learning PCB artwork design, soldering techniques, testing and troubleshooting etc.
7) Prepare a technical report based on the Research projects/ Industrial project /Project
8) Deliver technical seminar based on the Research projects/ Industrial project /Project work carried out.

D) Execution of Research projects/ Industrial project /Project

- The project can be undertaken in house or in an industry or in a research/ service organization.
- Project can select by individual student.
- Project group shall consist of **not more than 2** students per group.
- Research projects/ Industrial project /Project work should be carried out in the Design / Projects Laboratory.
- Project designs ideas can be necessarily adapted from recent issues of electronic design magazines Application notes from well known device manufacturers may also be referred.
- Use of Hardware devices/components is mandatory.
- Layout versus schematic verification is mandatory.
- Bare board test report shall be generated.
- Assembly of components and enclosure design is mandatory.

E) Selection: Domains for Research projects/ Industrial project /Project may be from the following, but not limited to:

j) Instrumentation and Control Systems
k) Electronic Communication Systems
l) Biomedical Electronics
m) Power Electronics
n) Audio , Video Systems
o) Embedded Systems
p) Mechatronic Systems

q) Microcontroller based projects should preferably use Microchip PIC controllers / ATmega controller / AVR microcontrollers / Ardino / Rasberry Pi.
r) Material science

F) **Monitoring: (for students and teachers both):** Suggested Plan for various activities to be monitored by the teacher.
Week 1 & 2: Formation of groups, Finalization of research project/ Project & Distribution of work.
Week 3 & 4: PCB artwork design using an appropriate EDA tool, Simulation.
Week 5 to 8: PCB manufacturing through vendor/at lab, Hardware assembly, programming (if required) Testing, Enclosure Design, Fabrication etc
Week 9 & 10: Testing of final product, Preparation, Checking & Correcting of the Draft Copy of Report
Week 11 & 12: Demonstration and Group presentations.
Log book for all these activities shall be maintained and shall be produced at the time of examination.

D. Report writing: A project report with following contents shall be prepared:

- Title
- Specifications
- Block Diagram
- Circuit Diagram
- Selection of components, calculations
- Simulation Results
- PCB Art work
- Testing Procedures
- Enclosure Design
- Test Results & Conclusion
- References
- Project report contain header of project title and footer with name of student

CIE Evaluation shall be done with marks distribution as follows:

• Selection of the topic & formulation of objectives	10%
• Design and simulation/ algorithm development/experimental setup	25%
• Conducting experiments / implementation / testing / analysis	25%
• Demonstration & Presentation	20%
• Report writing	20%

End Semester Evaluation (ESE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization.

The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

The guidelines of the assessment of the project for end-semester examination are as follows

Sr. No.	Performance Criteria	Max %	Rating (%)				
			Excellent	Very Good	Good	Fair	Poor
1	Selection of Project	10	10	08	06	04	02
2	Planning & Implementation	10	10	08	06	04	02
3	Quality of Performance	20	20	16	12	08	04
4	Regularity of Work carried	10	10	08	06	04	02
5	Report Writing Skills	10	10	08	06	04	02
6	Self Expression, Communication Skill and Presentation	10	10	08	06	04	02
7	Viva-Voce	20	20	16	12	08	04
8	Project idea present in research Journal	10	10	08	06	04	02
Total		**100**	**100**	**80**	**60**	**40**	**20**

GUIDELINES FOR INDUSTRIAL VISITS

Student must visit a minimum of two organizations/industry in per semester.

1) The duration of the visit per organization must be for ONE full day, during which he/she must comprehend the importance of organization structure, function of various departments, application of engineering knowledge, resource management, importance to environment and safety, professional ethics.
2) It is mandatory to visit ONE private multi-national company or public sector industry / organization, ONE medium-small enterprise and ONE rural based or NG organization.
3) The student must submit letter from the industry clearly specifying his / her name and the date of visit to the industry with authorized signatures.
4) Industrial visit must be related to the field of specialization or the M.Tech program in which the student has enrolled.
5) Every student has to write and submit his/her own report on each industrial visit and submit the report to the designated faculty advisor for evaluation.
6) A photograph outside the industry with the name and logo of the industry in the background along with the students and faculty members could be included in the report.
7) Students have to make a presentation on their industrial visit in front of the departmental committee and only upon approval of the presentation should the student proceed to prepare and submit the hard copy of the final report.
8) The reports shall be printed on bond paper – 80GSM, back to back print, with soft binding – A4 size with 1.5 spacing and times new roman font size 12.
9) The broad format of the industrial visit report shall be as follows

   • Cover Page

   • Certificate from College

   • Acknowledgement

• Synopsis / Executive Summary

• Table of Contents

• Chapter 1 - Profile of the PSU or MNC – must include Organizational structure, Products, Services, Financials, Manpower, Societal Concerns, Professional Practices

• Chapter 2 – Profile of the SME – must include Organizational structure, Products, Services, Financials, Manpower, Societal Concerns, Professional Practices

• Chapter 3 - Profile of the NGO – must include Organizational structure, services, Manpower, Societal Concerns, Professional Practices

• Chapter 4 – Comparative Analysis of PSU/MNC – SME – NGO

• References & Annexure (Permission letters from the organizations for the visit & photographs)