Advance Course

in

Electronic Product Design

NATIONAL INSTITUTE OF ELECTRONICS AND INFORMATION TECHNOLOGY

(An Autonomous Scientific Society of
Ministry of Electronics & Information Technology, Govt. of India)

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Syllabus

of

Advance Course in

Electronics Product Design

Objective

Electronic Products are pervasive in all areas of society and knowledge of how to design Electronic Systems based on Embedded and IoT is a vital skill for Engineers. Thus, objective of this course is to equip the students in enhancing their knowledge and skills based on power supply and embedded IoT. The course will help the students to understand the Ergonomics and Reliability of the Product and its packaging with the necessary fundamental knowledge and skills. The students will be able to design from basic to advance level of IoT Based System where a Microcontroller, Internet & Communication Protocols, Sensors & Actuators are convergent on common platform to Monitor, Control and Process the information for **EVERY THINGS.**

Course Learning Outcome (CLO)

On completion of this course the students will be able to

- Apply product development process for realization of the product.
- Design and develop a standalone Embedded System using Microcontrollers through conceptual design, PCB Design, PCB Assembly, Testing, Integration etc.
- Understand how to control anything using IoT and Cloud Platform by designing and developing IoT based systems.
- Electronic System Packaging and Rapid Prototyping

<table>
<tr><th colspan="5">Advance Course in Electronic Product Design</th></tr>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Course Title</th><td colspan="3">Teaching Hours</td></tr>
<tr><td>Theory</td><td>Lab</td><td>Total</td></tr>
<tr><td>EPDT-101
EPDL-151</td><td colspan="2">PCB Design and Manufacturing.</td><td>150</td><td>50</td><td>200</td></tr>
<tr><td>EPDT-102
EPDL-152</td><td colspan="2">IoT Applications & Product Design</td><td>150</td><td>50</td><td>200</td></tr>
<tr><td>EPDT-103
EPDL-153</td><td colspan="2">Ergonomics and Packaging for Electronic Products</td><td>150</td><td>50</td><td>200</td></tr>
<tr><th colspan="6">Project (Elective)</th></tr>
<tr><td>EPDP-201</td><td colspan="4">Microcontroller Based Embedded System Design</td><td rowspan="3">200 Hrs</td></tr>
<tr><td>EPDP-202</td><td colspan="4">Power Supply Design</td></tr>
<tr><td>EPDP-203</td><td colspan="4">IoT based Design</td></tr>
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Detailed Syllabus

EPDT-101: PCB Design and Manufacturing.

Unit-1: Power Supply Design (40 Hrs)

- Introduction, Basic Circuit Configuration and Characteristics of Series, Shunt and Adjustable Regulators, Current Limiting and Current Boosting Regulator.
- Introduction to Switching Regulator, Regulator Circuit Design using IC 723, IC78XX and IC79XX, Designing of power supplies.
- Introduction, Overview of Switching power Supply, DC to DC Converter, Buck Converter, Boost Converter and Buck- Boost Converter.
- Fly-back Converter, Forward Converter, Push-pull Converter, Half & Full bridge converter, Special converters.
- PWM control techniques, Study of PWM control ICs, Design of base drive.

Unit-2: Introduction to PCB Design using OrCAD tool. (50 Hrs)

- Introduction to PCBs and general guidelines, PCB design rules for various applications.
- Creation of new project in OrCAD tool, drawing the circuit in the schematic page using the components from the library.
- Simulation of Circuit using P-spice Simulation for verification of results, adding footprints to the components from the library.
- Creating the netlist, importing the components on ORCAD PCB Editor.
- Placing and moving the components in PCB Editor as per design sequence, Routing between the components. Generating pdf files and Gerber files

Unit-3: PCB Fabrication Process. (45 Hrs)

- PCB Manufacturing Techniques, Film Master Generation methods, Plating and Etching Techniques, punching, drilling, milling.
- Study Soldering Techniques, Study of soldering defect and rectification. Based on theory- Practical and Assignment in Design, Manufacturing and Assembly

Unit-4: Electromagnetic Interference. (25 Hrs)

- Overview of Electromagnetic Interference and Electromagnetic Compatibility, Occurrence of EMI, Considerations for EMC and EMI.
- Reduction techniques for EMI, Safety Ground, Grounding Schemes, Differences between Analog and Digital Ground.
- Shielding Techniques, Line Impedance Stabilization, Network (LISN), Conducted Noise, Common Mode Noises (CM), Differential Mode Noises (DM), EMI filter Design.

List of Experiments (50 Hrs)

- Theory and Lab sessions will be conducted simultaneously.

EPDT-102: IoT Applications & Product Design.

Unit-1: Microcontroller and Embedded Systems Basics (30 Hrs)

- Harvard Vs Van New Man Architecture, RISC Vs CISC, Microprocessor Vs Microcontroller.
- Families and Architecture of 8051 Microcontroller, functional description, Pins details and I/O Ports.
- Microcontroller Registers, Timing Diagram, Timer/Counter Operation Interrupts, memory organization, addressing modes, Instruction set.
- Case study of IC 89C20151.

Unit-2: Programming the Microcontroller (40 Hrs)

- Working of Microcontrollers, writing Assembly Language Program, Loading the program in code memory, Types of programming tools-KEIL.
- Programmable power supply, mono-stable pulse generator, square wave clock pulse generator.

Unit-3 : IoT Basics (80 Hrs)

- IoT Architecture and Stacks, Networking and Communication Protocols for IoT, Cloud Environment and IoT applications
- IoT Microcontroller Architecture and GPIOs Applications - Arduino, Raspberry Pi, ESP8266 and ESP32
- Tradeoff for choosing Arduino, Raspberry Pi, ESP32 and ESP8266
- Hardware Communications Modules – Wi-Fi, Zig-Bee, GSM, Bluetooth, RFID etc.
- Sensors and Actuators: Temperature, Humidity, PIR Motion Sensor, RFID, Relays etc.
- Setting up Arduino – IDE, Programming and Interfacing for choosing Arduino, Raspberry Pi and ESP32.
- Tradeoff between Arduino, Raspberry Pi and ESP32
- Basics of Cloud: Thing Speak, Message Queuing Telemetry Transport
- Detailed study of ESP32.

List of Experiments (50 Hrs)

- Theory and Lab sessions will be conducted simultaneously.

EPDT-103: Ergonomics and Packaging for Electronic Products.

Unit-1: Ergonomics and Aesthetics in Electronic Product Design. (30 Hrs)

- Overview of Electronic Product Design, Top-Down and Bottom-Up Approach, Considering Power Supply Design as an example, Ergonomic and Aesthetics.
- Definition with Example, issues in Designing Electronic Products, Design of Controls and Display w.r.t. Ergonomic and Aesthetics Consideration.

Unit-2: System Reliability Concepts. (30 Hrs)

- Introduction to concepts of reliability, nature of reliability problems in electronic equipment, series configuration, Parallel Configuration, Mixed Configuration,
- Methods of Solving Complex Systems, Mean Time to Failure (MTTF) and Mean Time between Failures (MTBF) of Systems.
- Maintainability, Availability Concepts, System Downtime, Mean Time to Repair (MTTR).
- Fault Tree Analysis- Concepts and Procedures, Rules for Fault Tree Construction.

Unit-3: Packaging Overview (50 Hrs)

- Packaging & Enclosures of Electronic System: Effect of environmental factors on electronic system (environmental specifications), nature of environment and safety measures. Packaging's influence and its factors.
- Cooling in/of Electronic System: Heat transfer, approach to thermal management, mechanisms for cooling, operating range, basic thermal calculations, cooling choices, heat sink selection

Unit-4: 3D Printing and Computer Aided Design. (40 Hrs)

- Surface Modelling, Rendering and Shading, Sources of New Ideas, Creativity Techniques, Form-factor, Shape, Colour and Graphics etc.
- Introduction to 3D Printers, Hierarchical Structure of Additive Manufacturing Processes, Integration of Additive Manufacturing in the Product Development Process, Rapid Prototyping, Rapid Tooling, Rapid manufacturing.

List of Experiments (50 Hrs)

- Theory and Lab sessions will be conducted simultaneously.

Reference Books:

- Complete PCB Design Using Or-Cad Capture and Layout Book by Kraig Mitzner
- Designing the Internet of Things Book by Adrian McEwen and Hakim Cassimally
- Practical Reliability Engineering 4th Edition.
- Avram Bar - Cohen & Allan Craus, "Thermal Analysis and Control of Electronic Equipment", McGraw Hill, Hemisphere Pub. Co., New York 1983.
- Harper, "Handbook of Electronic Packaging", McGraw Hill, New York 1979.
- Walter C Bosschard, "PCB design & Technology", McGraw Hill, New Delhi.
- Ronald A. Reis, "Electronic Project Design and Fabrication", Prentice Hall.
- Tim Williams, EMC for Product Designers, 4th ed.-Newnes.
- A.K. Chitale, R.C. Gupta, "Product Design and Manufacturing", Prentice, Hall of India.
- V.S. Bagad, "Electronic Product Design", Technical Publications.
- Dave S. Steinberg, "Cooling techniques for electronic equipment", Wiley, 1991
- Ernest Paul DeGarmo, J. T. Black, Ronald A. Kohser "Materials and Processes in Manufacturing", John Wiley & Sons.
- Patrick O'Connor & Andre Kleyne, "Practical Reliability Engineering", 5th ed., Wiley Publication.
- Milton Ohring, "Reliability and Failure of Electronic Materials and Devices", Academic Press.
- Dale H. Besterfield, "Total Quality Management", 3rd ed., Pearson Education.
- L. Suganthi & A. Samue, "Total Quality Management", PHI Learning Pvt. Ltd.

Project (Elective)

200 Hrs

The project work shall be of a nature of real-life product/system design and development. The problem may be selected from the list provided or from industry/ institution. The student shall follow all the phases and activities as followed in an industry, using state of art design and development tools and techniques.

EPDL-201: Microcontroller Based Embedded Systems Design

1. To develop and execute Assembly Language Program for 89C2051 based Moving Message Display.
2. To develop and execute Embedded-'C' program to interface relays to the Microcontroller 8051.
3. To develop and execute Celsius scale thermometer using 89C51 Microcontroller.
4. 89C2051 microcontroller-based IR Remote controlled Smart Fan.
5. 89C2051 microcontroller-based Traffic Light.

EPDL-202: Power Supply Design

1. Design of Linear regulated DC Power supply using IC3524 for +12V/1A
2. Design of Linear regulated DC Power supply for +5V/3A with CCCV feature.
3. Design of switching Power supply using IC3524 for +12V/1A with current limit feature
4. Design of Variable Power supply using linear regulator for 0-12V/1A
5. Design of variable switching Power supply for 0-12V/1A with current limit feature.

EPDL-203: IoT based Design

1. Motion detector with email notification using IoT
2. Vending machine using Arduino
3. Heart Beat monitoring over internet using IoT
4. Air pollution monitoring using IoT
5. Smart Dustbin with message notification
6. Gesture controlled wheel chair using Arduino

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