Course Title: ELE – CP3: EMBEDDED C AND DIGITAL DESIGN USING VERILOG	Course Credits: 2
Total Contact Hours: 56 Hrs.	Duration of ESA: 4 Hrs.
Formative Assessment Marks: 10 marks	Summative AssessmentMarks: 40 marks

Course Outcomes (COs):

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

1. Aptitude to apply Logic thinking and Basic Science knowledge for problem solving in various fields of electronics both in industries and research.
2. To acquire experimental skills, analyzing the results and interpret data.
3. Ability to design / develop / manage / operation and maintenance of sophisticated electronic gadgets / systems / processes that conforms to a given specification within ethical and economic constraints.
4. Capacity to identify and implementation of the formulae to solve the electronic related issues and analyze the problems in various sub disciplines of electronics.
5. Capability to use the Modern Tools / Techniques.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with ProgramOutcomes (POs)

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6
Aptitude to apply Logic thinking and Basic Science knowledge for problem solving in various fields of electronics both in industries and research						
To acquire experimental skills, analyzing the results and interpret data.	x					
Ability to design / develop / manage / operation and maintenance of sophisticated electronic gadgets / systems / processes that conforms to a given specification within ethical and economic constraints.	x					
Capacity to identify and implementation of the formulate to solve the electronic related issues and analyze the problems in various sub disciplines of electronics.						
Capability to use the Modern Tools / Techniques.	x					

ELE-CP3: **Embedded C & Digital Design using Verilog – LAB**

Section – A: **C – Programming**:

- C Programming Fundamentals:(Minimum "**THREE**" programs to be executed)

1. Fibonacci series up to given limit.
2. Factorial using recursion and iteration.
3. Menu-driven program using functions for math operations
4. Find max and min in an array
5. Implement linear and binary search

- Embedded C Fundamentals - (With Hardware): (Minimum "**THREE**" programs to be executed)

1. Blinking an LED Initialize I/O ports, Toggle an LED with a simple delay loop

   Blink one LED with a 1-second delay

   Modify to blink at 0.5 seconds
2. Switch Interface & Debouncing: Read switch input, Control an LED based on switch state

   Toggle LED when switch is pressed, Implement software debounce, Turn on LED only while switch is held high.
3. Timer-based LED Control: Configure Timer 0/1 in mode 1 (16-bit) Use timer for precise delays of 1 second, Blink LED using hardware timer (no delay loops), Vary LED blinking rate using different timer reload values
4. LCD interfacing to display "HELLO WORLD" with static and scrolling format of display
5. PWM & Motor Control: Generate PWM signal (using timer or software), Control speed of motor with PWM

Section B: **Digital Design Using Verilog with FPGA kit**
(Minimum **SIX** Programs is to be written and executed)

1. Realization of gates using Verilog code.
2. Realize Adder/Subtractor (Half) circuits using Verilog data flow description.
3. Realize Adder/Subtractor (Full) circuits using Verilog data flow description.
4. Realize the following code converters using Verilog behavioural description.
   a) Gray to Binary and vice-versa.
   b) Binary to excess 3 and vice-versa.
5. To realize 4-bit ALU using Verilog program.
6. To realize using Verilog behavioural description: 8:1 multiplexer, 8:3 encoder.
7. To realize using Verilog behavioural description: 1:8 DE multiplexer, 3:8 decoder.
8. To realize using Verilog behavioural description flip flops:
   (a) D-type (b) JK - type (c) T-type
9. To realize counters: Up/down (Binary) using Verilog behavioural description.
10. To realize counters: Up/down (BCD) using Verilog behavioural description.

Note: It is suggested to carry out one **mini project** on **Embedded C** for awarding **IA marks**

- **List of simulators:**
  - Keil µVision Simulator
  - Proteus Design Suite
  - PICSim Lab
  - QEMU (Quick Emulator)
  - Web-Based Microcontroller Simulators

- **Exercise programs :**

1. Display a welcome message using printf()
2. Accept and display user details (name, age, etc.)
3. Perform arithmetic operations on two integers
4. Evaluate a compound expression using all arithmetic operators
5. Demonstrate use of relational and logical operators
6. Convert temperature between Celsius and Fahrenheit
7. Check if a number is even or odd using if-else
8. Implement a calculator using switch-case
9. Generate multiplication tables using forloop
10. Write a function to check for prime numbers
11. Count vowels, digits, and spaces in a string
12. Perform string operations: copy, reverse, compare

Syllabus for Elective Subjects

ELE – Elective 3.1: **Renewable Energy and Energy harvesting** 26 Hours.

Learning Objectives:

- To introduce various kinds of renewable energy sources.
- To understand the scenario of power generation in both conventional and non- conventional in Indian context.

Unit-I 8 Hrs.

Conventional Energy sources:

Coal, Oil, Natural Gas, Nuclear power and Hydro - their utilization pattern in the past, present and future projections of consumption pattern - Sector-wise energy consumption – environmental impact of fossil fuels – Energy scenario in India – Growth of energy sector and its planning in India. Non-Conventional Energy Sources: Solar Energy, Wind Energy, Energy from Biomass & Biogas, Ocean Thermal Energy Conversion, Tidal Energy, Geothermal Energy, Hydrogen Energy, Fuel Cell, Magneto Hydro-Dynamics Generator, Advantages& Limitations of Non-Conventional Energy Sources

Unit-II 9 Hrs.

Solar Energy

Solar cells for direct conversion of solar energy in to electric power, Solar cell parameter, Solar cell VI characteristics, Efficiency, single crystal silicon solar cells, polycrystalline silicon solar cells, Cadmium supplied solar cells, Application of solar energy- solar water heating – space heating and space cooling- solar photovoltaic cell – solar distillation - solar pumping - solar furnace- solar cooling – solar greenhouse. Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping etc. - solar PV power plant – Net metering concept, problems.

Unit-III 9 Hrs.

Wind and Bio mass energy

Nature of the wind – power in the wind – factors influencing wind – wind data and energy estimation -wind speed monitoring - wind resource assessment - Betz limit - site selection - wind energy conversion devices - classification, characteristics, applications

Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - direct combustion – biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - types of biogas Plants - applications - alcohol production from biomass – bio diesel production – Urban waste to energy conversion - Biomass energy programme in India. Electricity observed in living systems, Problems.

REFERENCES:

1. Non-Conventional Energy Sources, G. D. Rai, Khanna Publication.
2. Non-Conventional Energy Resources, B. H. Khan, The McGraw Hill Publishers. FLUID ECHANICS
3. Properties of Matter – Brijlal & Subramanyam, Eurasia Publishing House, 1991
4. Heat and Thermodynamics, D.S. Mathur, S.Chand& Co Ltd
5. Heat and Thermodynamics - Mark W.Zemansky and Richard H. Basic, McGraw Hill, New York, seventh edition.
6. Theory and experiment on Thermal Physics- P.K.Chakrabarti
7. Heat and Thermodynamics- Brijlal & Subramanium, S.Chand
8. An Introduction to Mechanics, D. Kleppner and R. J. Kolenkow
9. Thermal Physics- Kittel, CBS Publishers, 1987.

Experiments

1. Solar cell dark and illuminated characteristics
2. Solar cell - Spectral response
3. Calorific value of Biomass samples
4. Demonstrate the understanding of the operational details of the Wind Lab laboratory equipment and to plot a graph of current verses time.
5. Determine the speed of the wind turbine
6. Comparison of performance of solar pumps vs. conventional pumps
7. Wind turbines, Savonius rotors
8. Compare the amount of biogas that is produced from different types of biomass
9. Characteristics of a photocell

ELE – Elective 3.2: **Power Electronics and Electric Vehicles** 26 Hours.

Prerequisites: Basic knowledge of Electrical Circuits and Semiconductor Devices.

Course Description

This course introduces the fundamental principles of Power Electronics and their essential role in the operation of Electric Vehicles (EVs). Students will gain an understanding of key power converter topologies, common EV architectures, and the application of power electronics in EV propulsion, energy storage, and charging systems.

Course Objectives

Upon successful completion of this course, students will be able to:

1. Identify and describe the characteristics of common power semiconductor devices.
2. Explain the operation of basic DC-DC, AC-DC, and DC-AC power converters.
3. Outline the main components and architectures of various electric vehicle types.
4. Describe the application of power electronics in EV motor drives, battery management, and charging.
5. Discuss emerging trends in EV power electronics.

Unit 1: **Fundamentals of Power Electronics** 9 Hrs.

This unit lays the groundwork by introducing power semiconductor devices and the essential DC-DC and AC-DC conversion principles.

Introduction to Power Electronics & Devices

Overview: Role of power electronics in modern systems, specifically EVs.

Power Semiconductor Devices: Diodes, MOSFETs & IGBTs V-I characteristics, switching behavior, key advantages in power applications, Brief mention of Wide Bandgap Devices (SiC, GaN) for EVs.

Device Protection: Introduction to snubber circuits.

DC-DC Converters

Principles: Basic operation, role in voltage conversion.

Step-Down (Buck) Converter: Circuit, operation (continuous mode), voltage conversion ratio.

Step-Up (Boost) Converter: Circuit, operation (continuous mode), voltage conversion ratio.

Control Basics: Introduction to Pulse Width Modulation (PWM).

Unit 2: **AC Conversion and EV Fundamentals** 9 Hrs.

AC-DC Converters (Rectifiers)

Uncontrolled Rectifiers: Single-phase full-wave rectifier (bridge), concepts of average DC voltage, ripple.

Controlled Rectifiers (Brief): Introduction to phase control using Thyristors (SCRs), basic concept.

Power Factor Correction (PFC): Why it's needed, brief overview of active PFC.

DC-AC Converters (Inverters)

Introduction: Role in converting DC battery power to AC for motors.

Single-Phase Inverters: Half-bridge and full-bridge topologies, square wave output.

Three-Phase Inverters: Basic operation, 6-step waveform generation.

Pulse Width Modulation (PWM) for Inverters: Sinusoidal PWM (SPWM) for harmonic reduction.

Unit 3: **Power Electronics in Electric Vehicles** 8 Hrs.

Electric Vehicle Fundamentals

EV Classification: BEVs, HEVs, PHEVs, FCEVs – basic definitions and characteristics.

EV Architectures: Simple block diagrams of series, parallel, and BEV powertrains.

Key EV Components: Electric Motors: Introduction to PMSM and Induction Motors used in EVs. Batteries: Types (Li-ion focus), basic characteristics (voltage, capacity, C-rate), overview of Battery Management System (BMS) functions.

Bidirectional DC-DC Converters: Importance in EV applications (e.g., HEVs, V2G).

Power Electronics in EV Applications & Trends

Motor Drives: Role of the inverter in controlling electric motors (basic concepts of speed control).

Regenerative Braking: Principle and energy recovery.

EV Charging Systems: On-board vs. Off-board charging, AC Charging (Level 1 & 2), DC Fast Charging (Level 3), Basic block diagram of a typical EV charger.

Auxiliary Power: Brief mention of DC-DC converters for 12V/48V systems.

Future Trends: Brief discussion on V2G and wide bandgap device adoption.

REFERENCES: (Selected chapters for brevity)

1. **"Power Electronics: Converters, Applications, and Design"** by Ned Mohan, Tore M. Undeland, William P. Robbins. Wiley. (Focus on first few chapters for devices and basic converters)
2. **"Electric Vehicles: Principles, Design and Applications"** by Iqbal Husain. CRC Press. (Focus on introductory chapters and powertrain)