

**SEC**

## Semester III

**Physics (Skill Enhancement Course) - 2 credits, (60 Hours)**

**Course code: USPHSEC2**

**Title: - Battery and Inverter Testing and Maintenance**

### **Battery and Inverter Testing and Maintenance Practical Course**

This course is designed for learners to get exposure with various aspects of battery and inverter, their usage through practical and hands-on mode.

**Passing standards for SEUSPHSEC2 Practical:**

**Total Credit: 02 (60 Hours)**

**Total Marks: 50**

**c) 40% Internal Continuous assessment: 20 Marks**

**d) 60% External Semester End Examination: 30 marks**

**Note: Individual Passing in Internal and External Examination**

#### **Instructions:**

- All the measurements and readings should be written with proper units in SI system only.
- After completing all the required number of experiments in the semester and recording them in journal, student will have to get their journal certified and produce the certified journal at the time of practical examination.
- While evaluating practical, weightage should be given to circuit/block diagram, observations, tabular representation, experimental skills and procedure, graph, calculation and result.
- Skill of doing the experiment and understanding physics concepts should be more important than the accuracy of final result.

#### **Learning Outcomes:**

**On successful completion of this course students will be able to:**

1. understand of the various types of batteries, their construction, and materials used in

their design.

2. Equip students with the knowledge of testing methods to evaluate battery performance and lifespan.
3. Understand the fundamentals of inverters, including their design, working principles, and applications.
4. Design inverters for different applications with an understanding of power conversion principles and component selection
5. Understand & practice the skills while performing experiments.
6. Understand the use of apparatus and their use without fear & hesitation.
7. Correlate the physics theory concepts to practical application.
8. Troubleshoot common inverter and UPS faults using logical fault-finding methods and testing instruments.

#### **Internal Continuous USPHSEC2practical Evaluation pattern for 20 Marks**

| Sr. No. | Activity                                                                                      | Total 20 Marks |
|---------|-----------------------------------------------------------------------------------------------|----------------|
| 1       | Assignment or Test on practical skill experiment (Any one experiment from Group A or Group B) | 10 Marks       |
| 2       | viva -voce                                                                                    | 05 Marks       |
| 3       | Overall performance                                                                           | 05 Marks       |

- Semester end Practical Examination Evaluation pattern for USPHSEC2 (30 Marks)
- Duration of the practical examination: 2 Hours

| Sr.No. | Activity                               | Total 30 Marks |
|--------|----------------------------------------|----------------|
| 1      | One experiment from Group A or Group B | 20 Marks       |
| 2      | Certified Journal                      | 05 Marks       |
| 3      | Viva-Voce                              | 05 Marks       |

#### **Semester end Examination (30 Marks)**

- For practical examinations, the learner will be examined in one experiment.
- Experiment will be of two hours duration.
- A Minimum **TEN** experiment (minimum **Five experiment** from Group A And Group B) must perform and reported in journal.
- Evaluation in viva voce will be based on regular experiments.
- A learner will be allowed to appear for the semester end practical examination

only if he/she submits a certified journal of Physics with a certificate that the

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|   | <p>learner has completed the practical course of Physics Semester-III as per the minimum requirements.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 1 | <p><b>Group A: Battery Testing and Maintenance</b></p> <ol style="list-style-type: none"> <li><b>Study of specifications of Battery provided by the manufacturer</b> (capacity, maximum charge voltage, maximum continuous current, discharge cut-off voltage, temperature range etc.)</li> <li><b>Voltage, Capacity and Internal resistance Measurement of a Battery</b> <p><b>Aim:</b> To measure the voltage, capacity and internal resistance of a given battery using a Multimeter and electronic load.</p> <p><b>Theory:</b> The voltage of a battery indicates its electrical potential difference between the terminals. Capacity (measured in mAh or Ah) indicates how much charge a battery can store. Using a Multimeter, the open-circuit voltage (OCV) provides a quick health check of the battery. Using a load test, the internal resistance can be calculated using Ohm's law by measuring the voltage drop across a known load.</p> </li> <li><b>Verification of Ohm's Law Using a Battery and Resistors.</b> <p><b>Aim:</b> To verify Ohm's Law by measuring voltage and current through multiple resistors.</p> <p><b>Theory:</b> Ohm's Law states that <math>V = IR</math>, showing the relationship between voltage (V), current (I), and resistance (R). By connecting a battery to resistors and measuring voltage and current, Ohm's Law can be verified practically.</p> </li> <li><b>Series and Parallel Connection of Batteries &amp; their effect on Voltage and Current</b> <p><b>Aim:</b> To study how connecting batteries in series and parallel affects voltage and current.</p> <p><b>Theory:</b> Connecting batteries in series increases voltage while keeping the current the same, whereas parallel connection increases current capacity while maintaining the same voltage. (For example, for parallel connection due to the difference in capacity between a battery, it may affect their discharge rates and lifespan. We recommend connecting batteries of the same type with matching voltage, capacity, and battery management systems.) Understanding these principles for designing battery packs to provide unified power source.</p> </li> <li><b>Measurement of Battery Terminal Voltage Under Load, No-Load Conditions and Testing Battery Performance under Load</b></li> </ol> |

**Aim: Measurement of Battery Terminal Voltage Under Load, No-Load Conditions and Testing Battery Performance under Load**

**Theory:** Comparing terminal voltage under load and no-load conditions highlights the effect of internal resistance (current should be beyond  $I_L$  max.). A significant voltage drop under load indicates higher internal resistance or a weak battery.

Under load conditions, a battery's terminal voltage typically drops. This practical evaluates the battery's ability to maintain voltage and supply current, demonstrating performance under real-world conditions.

**6. Determining the Charging and Discharging Time of a Battery.**

**Aim:** To measure how long a battery takes to charge and discharge under a specific load.

**Theory:** Charging and discharging times depend on the battery capacity and the applied current. Constant current and constant voltage (CCCV) methods influence how fast a battery charges, while discharge time reflects energy delivery efficiency.

**7. Battery Self-Discharge Experiment.**

**Aim:** To observe and measure the self-discharge of a battery by recording voltage at intervals 24 Hr.( Time interval depends on observer for e.g. 4 Hr, 8 Hr, 12 Hr, etc.)

**Theory:** Self-discharge (concept of leakage resistance) is the natural loss of charge when a battery is not in use. Factors like temperature, age, and battery chemistry affect this rate. Observing voltage drop over time without load gives insights into self-discharge characteristics.

**8. Battery Inspection and Maintenance (Visual Inspection & Heavy Load Test)**

**Aim:** To inspect a battery for physical damage and test its capacity under heavy load

**Theory:** Regular inspection of batteries can prevent failures. Visual inspection helps identify physical damage, leaks, or corrosion. Heavy load testing assesses the battery's capacity to deliver power under stress, indicating its health.

**9. Effect of Temperature on Battery Voltage**

**Aim:** To observe and measure how the voltage of a battery changes with temperature variation.

**Theory:** Temperature impacts battery performance. Higher temperatures increase chemical activity, raising voltage temporarily but may lead to degradation. Cold temperatures reduce voltage and capacity, demonstrating the importance of temperature management.

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| 2. | <b>Group B : Inverter Testing and Maintenance</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|    | <ol style="list-style-type: none"> <li>1. <b>Study of specifications of Inverter provided by the manufacturer</b> (DC Input voltage range, AC output voltage, continuous output power at different temperature, peak power etc.)</li> <li>2. <b>Drawing the Block Diagram of an Inverter and Explaining Each Block</b><br/> <b>Aim:</b> To draw the block diagram of an inverter and describe the function of each block.<br/> <b>Theory:</b> An inverter is an electronic device that converts DC (Direct Current) to AC (Alternating Current). The basic block diagram of an inverter includes:<br/> DC Input Source, Oscillator Circuit, Driver Circuit, Power Stage (Switching Circuit), Output Filter.</li> <li>3. <b>Demonstrate and explain the working of Inverter and its different parts and its functions (PWM card, charging card, driver card etc.)</b></li> <li>4. <b>Generating an Oscillator Signal Using a 555 Timer IC(Astable mode)</b><br/> <b>Aim:</b> To study a simple oscillator circuit using the 555 Timer IC and observe the square wave output on the oscilloscope.</li> <li>5. <b>Making a Simple DC-AC Inverter Circuit</b><br/> <b>Aim:</b> To build a simple inverter circuit using a 555 Timer IC to convert DC to AC and observe the output.</li> <li>6. <b>Simulating an Inverter Output Using a Square Wave Generator</b><br/> <b>Aim:</b> To simulate an inverter by connecting a square wave generator to a load and observe the AC-like output on the oscilloscope. (This practical demonstrates how square wave signals can simulate AC output. By connecting the output of a square wave generator to a load, students can visualize the AC characteristics on an oscilloscope, showing the basic principle of how inverters create AC from DC.)</li> <li>7. <b>Analysis of Inverter Output Waveform Using an Oscilloscope</b><br/> <b>Aim:</b> To analyze the output waveform of an inverter (square/sine wave) using an oscilloscope. (When testing inverters, it is used to verify whether the output is a pure sine wave, modified sine wave, or square wave. Waveform shape impacts the efficiency and compatibility of the inverter with different types of loads.)</li> <li>8. <b>Testing Transformer Primary &amp; Secondary Voltages and Build a Simple Bridge Rectifier and Testing DC Output</b></li> </ol> |

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|   | <b>Aim:</b> To measure Transformer Primary & Secondary Voltages and construct a bridge rectifier and measure the rectified DC voltage.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 3 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|   | <p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Devid Linden – Handbook of Batteries Third ed. McGraw Hill (DLB)</li> <li>2. Muhammad H. Rashid-Power Electronics Circuits, Devices and Applications 4<sup>th</sup> edition Pearson.</li> </ol> <p><b>Additional Reference:</b></p> <ol style="list-style-type: none"> <li>3. Xiaojun Tan-Battery Management System and its Application, Wiley (XTB)</li> <li>4. Yan Bao-A Bi-Level Optimization Approach to Charging Load Regulation of Electric Vehicle Fast Charging Stations Based on a Battery Energy Storage System; MDPI (YBB)</li> <li>5. Ersan Kabalci-Multilevel Inverters: Introduction and Emergent Topologies; Academic Press (EKM)</li> <li>6. Thomas F. Schuber-Fundamentals of Electronics: Book 4 Oscillators and Advanced; Springer (TFE)</li> <li>7. Tetsuo Suzuki-Basic Knowledge Regarding Uninterruptible Power Supply (UPS) (TSB)</li> <li>8. K.C. Selvam- Design of Function Circuits with 555 Timer Integrated Circuit 1st Edition 2023 CRC Press</li> </ol> |
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