

| Unit      | Topic                                 | Sub-topic   | Cumulative Hours | Methodology | Remarks                          |
|-----------|---------------------------------------|---|------------------|-------------|----------------------------------|
| <b>I</b>  | Structure and Bonding Models          | Types of Hybridization  | 1                | Whiteboard  | Visual representation            |
|           |                                       | VSEPR Theory  | 2                | Whiteboard  | Molecular shapes                 |
|           |                                       | Molecular Orbital Theory - Basics                             | 3                | Whiteboard  | Bonding theory                   |
|           |                                       | MOT - Homonuclear diatomic (N <sub>2</sub> , O <sub>2</sub> ) | 4                | Whiteboard  | MO diagrams                      |
|           |                                       | MOT - Heteronuclear diatomic molecules                        | 5                | Whiteboard  | Examples like NO, CO             |
|           |                                       | MO of Butadiene   | 6                | Whiteboard  | $\pi$ bond system                |
|           |                                       | MO of Benzene   | 7                | Whiteboard  | Delocalized electrons            |
|           |                                       | Bond Order Calculations                                       | 8                | Whiteboard  | Problems based                   |
|           |                                       | Recap and Worksheet   | 9                | Whiteboard  | Practice session                 |
| <b>II</b> | Instrumental Methods and Applications | EM Spectrum and UV Basics                                     | 10               | Whiteboard  | Spectral regions                 |
|           |                                       | UV-Vis: Chromophores & Auxochromes                            | 11               | Whiteboard  | Structural identification        |
|           |                                       | Absorption & Intensity Shifts                                 | 12               | Whiteboard  | $\lambda_{\text{max}}$ variation |
|           |                                       | IR Spectroscopy Fundamentals                                  | 13               | Whiteboard  | Vibrational modes                |
|           |                                       | IR Instrumentation & Fingerprint Region                       | 14               | Whiteboard  | Diagram-heavy                    |
|           |                                       | NMR: Principle & Proton Types                                 | 15               | Whiteboard  | Magnetic nuclei                  |
|           |                                       | NMR: Chemical Shift   | 16               | Whiteboard  | Scale and reference              |
|           |                                       | NMR: Splitting & Coupling                                     | 17               | Whiteboard  | Peak analysis                    |

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|------------|---------------------------------|---|----|------------|--------------------------|
|            |                                 | Recap and Sample Problems                           | 18 | Whiteboard | Q&A session              |
| <b>III</b> | Electrochemistry & Applications | Electrochemical Cell & Nernst Equation              | 19 | Whiteboard | Equation derivation      |
|            |                                 | EMF Problems  | 20 | Whiteboard | Numericals               |
|            |                                 | Potentiometric Titrations                           | 21 | Whiteboard | Redox examples           |
|            |                                 | Conductivity Concept & Cell                         | 22 | Whiteboard | Instrumental setup       |
|            |                                 | Conductometric Titrations                           | 23 | Whiteboard | Graphical curves         |
|            |                                 | Electrochemical Sensors                             | 24 | Whiteboard | Applications             |
|            |                                 | Reference Electrodes (Calomel, SHE)                 | 25 | Whiteboard | Diagrams                 |
|            |                                 | Primary Cell - Zinc-air                             | 26 | Whiteboard | Cell reactions           |
|            |                                 | Secondary Cell - Li-ion                             | 27 | Whiteboard | Charging/discharging     |
|            |                                 | Fuel Cells (H <sub>2</sub> -O <sub>2</sub> , PEMFC) | 28 | Whiteboard | Real-world uses          |
| <b>IV</b>  | Polymer Chemistry               | Intro & Functionality of Monomers                   | 29 | Whiteboard | Basic concepts           |
|            |                                 | Chain-Growth & Step-Growth Polymerization           | 30 | Whiteboard | Mechanisms               |
|            |                                 | Coordination Polymerization                         | 31 | Whiteboard | Catalyst-based           |
|            |                                 | Thermoplastics vs Thermosets                        | 32 | Whiteboard | Table comparison         |
|            |                                 | PVC & Teflon: Preparation, Properties               | 33 | Whiteboard | Structure-focused        |
|            |                                 | Bakelite, Nylon-6,6, PET                            | 34 | Whiteboard | Use-cases                |
|            |                                 | Elastomers – Buna-S, Buna-N                         | 35 | Whiteboard | Applications in industry |
|            |                                 | Conducting Polymers & Biodegradable Polymers        | 36 | Whiteboard | Polyacetylene, PLA       |

|          |                              |  |    |            |                           |
|----------|------------------------------|--|----|------------|---------------------------|
| <b>V</b> | Modern Engineering Materials | Semiconductors : Band Theory                   | 37 | Whiteboard | Energy levels             |
|          |                              | Intrinsic and Extrinsic Semiconductors         | 38 | Whiteboard | Doping explanation        |
|          |                              | Superconductors: YBCO Preparation & Properties | 39 | Whiteboard | Ceramic method            |
|          |                              | Applications of Superconductors                | 40 | Whiteboard | Medical, electronics      |
|          |                              | Supercapacitors: Principle & Mechanism         | 41 | Whiteboard | Charge storage            |
|          |                              | Supercapacitor Applications                    | 42 | Whiteboard | Transport, energy         |
|          |                              | Nanomaterials: Introduction & Classification   | 43 | Whiteboard | Size-dependent properties |
|          |                              | Fullerenes, CNTs, Graphene                     | 44 | Whiteboard | Diagrams and synthesis    |
|          |                              | Applications of Nanomaterials                  | 45 | Whiteboard | Sensors, drug delivery    |
|          |                              | Consolidation & Review (All Units)             | 46 | Whiteboard | Summary                   |
|          |                              | MCQ/Problem Solving Practice                   | 47 | Whiteboard | Quick revision            |
|          |                              | Final Doubt-Clearing and Model Questions       | 48 | Whiteboard | Preparation for exam      |