

R3638

Sub. Code

540301

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2025

Third Semester

Energy Science

PHOTOVOLTAICS

(CBCS – 2022 onwards)

Time : 3 Hours

Maximum : 75 Marks

Part A

(10 × 1 = 10)

Answer **all** the following objective type questions
by choosing the correct option.

1. A solar cell is a _____ (CO1, K2)
 - (a) P-type semiconductor
 - (b) N-type semiconductor
 - (c) P-N junction
 - (d) Intrinsic semiconductor
2. A forward biased P-N junction diode has a resistance of the order of (CO1, K1)
 - (a) Ω
 - (b) $k\Omega$
 - (c) $M\Omega$
 - (d) None of the above
3. Which type of silicon solar cell is known for having a single continuous crystal structure? (CO2, K2)
 - (a) Polycrystalline silicon solar cell
 - (b) Amorphous silicon solar cell
 - (c) Monocrystalline silicon solar cell
 - (d) Cadmium telluride solar cell

4. Which of the following best describes the Molecular Beam Epitaxy (MBE) method (CO2, K2)
- (a) It uses a chemical reaction to deposit thin films
 - (b) It involves the deposition of materials from a vapor source in a vacuum chamber
 - (c) It is used for the production of organic solar cells
 - (d) It deposits materials using a laser beam
5. The material commonly used as the electron donor in Organic Solar Cells (OSCs) is: (CO3, K1)
- (a) Titanium dioxide (TiO₂)
 - (b) Fullerene derivatives
 - (c) Silicon
 - (d) Copper indium gallium selenide (CIGS)
6. What is the primary material used in Perovskite Solar Cells (PSC)? (CO3, K1)
- (a) Silicon
 - (b) Copper indium gallium selenide (CIGS)
 - (c) Perovskite compounds
 - (d) Gallium arsenide
7. What is the main characteristic of identical solar cells in a photovoltaic system? (CO4, K2)
- (a) They have different efficiency levels
 - (b) They are made from different materials
 - (c) They have the same electrical properties and performance
 - (d) They operate at different voltage levels

8. Why are thermal considerations important in solar cell design? (CO4, K1)
- (a) To enhance the aesthetic appearance of solar panels
 - (b) To minimize heat generation and prevent efficiency loss
 - (c) To improve the mechanical strength of the solar cells
 - (d) To increase the weight of the solar panel for stability
9. Which key component is essential for synchronizing a grid-connected power system with the utility grid? (CO5, K1)
- (a) Solar panel
 - (b) Inverter
 - (c) Battery
 - (d) Charge controller
10. What is the main factor that affects the economics of Solar Photovoltaic (SPV) systems? (CO5, K2)
- (a) The color of the solar panels
 - (b) The availability of sunlight in the region
 - (c) The weight of the solar modules
 - (d) The distance from the utility grid

Part B

(5 × 5 = 25)

Answer **all** questions not more than 500 words each.

11. (a) Explore the concept of semiconductors and explain their properties with examples. (CO1, K4)

Or

(b) Explain semiconductor junctions and how they function. (CO1, K4)

12. (a) Differentiate between monocrystalline and polycrystalline solar cells. (CO2, K2)

Or

(b) Exhibit a brief explanation of the MBE (Molecular Beam Epitaxy) method. (CO2, K2)

13. (a) Evaluate the fabrication techniques used for Dye-Sensitized Solar Cells (DSSC). (CO3, K3)

Or

(b) Define a Perovskite Solar Cell (PSC) and explain how its working mechanism functions. (CO3, K3)

14. (a) Compare identical and non-identical solar cells. (CO4, K2)

Or

(b) Summarize the issues associated with solar PV modules and explain how module testing and analysis are conducted. (CO4, K2)

15. (a) Differentiate between a module and an array in PV (Photovoltaic) systems. (CO5, K4)

Or

- (b) Analyze specific-purpose photovoltaic systems and their applications. (CO5, K4)

Part C (5 × 8 = 40)

Answer **all** questions not more than 1000 words each.

16. (a) Analyze the materials used in solar cells and explain how their design is structured. (CO1, K4)

Or

- (b) Inspect the fabrication process for transparent conducting oxides, anti-reflection coatings, metal contacts, and the characterization of these devices. (CO1, K4)

17. (a) Explain the thin-film solar cells are and how their manufacturing process is carried out. (CO2, K2)

Or

- (b) Clarify the MOCVD (Metal-Organic Chemical Vapor Deposition) method, along with a clear diagram. (CO2, K2)

18. (a) Explain an Organic Solar Cell (OSC) and how it works. (CO3, K3)

Or

- (b) Illustrate the different types of Perovskite Solar Cells (PSC) with a clear diagram. (CO3, K3)

19. (a) Express the structure and assembly of a solar module and explain how it works. (CO4, K2)

Or

- (b) Explain solar PV concentrators, along with the materials and devices used in concentrator photovoltaics. (CO4, K2)
20. (a) Clarify power conditioning and regulation in PV (Photovoltaic) systems, and explain how it is implemented. (CO5, K4)

Or

- (b) Determine grid-connected power systems and remote area power systems, and explain how they differ. (CO5, K4)

R3639

Sub. Code

540302

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2025

Third Semester

Energy Science

ENERGY STORAGE SYSTEMS

(CBCS – 2022 onwards)

Time : 3 Hours

Maximum : 75 Marks

Part A

(10 × 1 = 10)

Answer **all** the following objective type questions by choosing the correct option.

1. Name the common device used for energy storage (CO1, K1)
(a) Solar panel (b) Wind turbine
(c) Battery (d) Geothermal pump
2. Which type of battery technology is known for its high specific energy and long cycle life? (CO1, K2)
(a) Nickel-cadmium (b) Lead-acid
(c) Lithium-sulfur (d) Zinc-carbon
3. Lithium cells operate, ranging from (CO2, K2)
(a) -25°C to 25°C (b) -50°C to 25°C
(c) -50°C to 75°C (d) -75°C to 75°C
4. During the charging and discharging of a nickel-iron cell (CO2, K1)
(a) Corrosive fumes are produced
(b) Water is neither formed nor absorbed
(c) Nickel hydroxide remains unspoil
(d) Its e.m.f. Remains constant

5. Electrolytes obey _____ to some extent as metallic conductors. (CO1, K2)
- (a) Specific conductance
 - (b) Ohms law
 - (c) Molecular conductance
 - (d) Equivalent conductance
6. The metals except _____ exist in nature in the form of their mineral's ores. (CO2, K1)
- (a) Gold
 - (b) Silver
 - (c) Copper
 - (d) Iron
7. A fuel cell is used to convert chemical energy into _____. (CO1, K2)
- (a) Mechanical energy
 - (b) Solar energy
 - (c) Electrical energy
 - (d) Potential energy
8. In standard hydrogen electrode, the concentration of hydrogen is _____. (CO1, K2)
- (a) 0 M
 - (b) 0.5 M
 - (c) 1 M
 - (d) 1.5 M
9. Which of the following cell has the highest voltage? (CO3, K1)
- (a) Mercury
 - (b) Lithium
 - (c) Carbon-Zinc
 - (d) Manganese-Alkaline
10. A dead storage battery can be revived by (CO1, K2)
- (a) Adding distilled water
 - (b) Adding so-called battery restorer
 - (c) A dose of H_2SO_4
 - (d) None of the above

Part B

(5 × 5 = 25)

Answer **all** questions not more than 500 words each.

11. (a) Explain the importance of energy storage in modern power systems. (CO1, K2)

Or

- (b) Outline the role of hydrogen fuel cells in energy storage. (CO1, K2)

12. (a) Pros and cons of lead acid battery. (CO2, K2)

Or

- (b) Discuss the charging properties of SLA batteries. (CO2, K6)

13. (a) Compare a lithium battery with a lithium-ion battery. (CO3, K2)

Or

- (b) Outline the advantages of using carbon nanotubes as an anode material in batteries? (CO3, K2)

14. (a) Discuss the role of electrodes in supercapacitors. (CO4, K6)

Or

- (b) Draw the neat diagram of a fuel cell and point out the components. (CO4, K1)

15. (a) Classify the different types of hybrid energy systems. (CO5, K2)

Or

- (b) Explain the basic working principle of a hybrid fuel cell system. (CO5, K2)

Part C

(5 × 8 = 40)

Answer **all** questions not more than 1000 words each.

16. (a) Compare and contrast the different types of batteries used for energy storage, including lead-acid, lithium-ion, and flow batteries. (CO1, K2)

Or

- (b) Explain the advantages and disadvantages of using supercapacitors for energy storage compared to batteries. (CO1, K2)

17. (a) Explain construction and working principle of lead acid battery? With a neat diagram of lead acid battery. (CO2, K2)

Or

- (b) Discuss the fabrication technologies in SLI batteries? Explain briefly? (CO2, K6)

18. (a) Show the various types of lithium-ion batteries, including their construction characteristics, and specific applications. (CO3, K2)

Or

- (b) Explain the potential applications of metal-air batteries in electric vehicles. (CO3, K2)

19. (a) Discuss the role of the electrode material in enhancing the performance of supercapacitors. Provide examples of commonly used materials. (CO4, K6)

Or

- (b) Elaborate the Characterization of Bipolar Plates in Fuel cell. (CO4, K6)

20. (a) Draw the neat diagram of battery/ supercapacitor hybrid system and explain it. (CO5, K2)

Or

- (b) Explain the mechanisms of energy conversion and storage in hybrid fuel cell systems. (CO5, K2)

R3640

Sub. Code

540303

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2025

Third Semester

Energy Science

ADVANCED INSTRUMENTAL METHODS OF ANALYSIS

(CBCS – 2022 onwards)

Time : 3 Hours

Maximum : 75 Marks

Part A

(10 × 1 = 10)

Answer **all** the following objective questions by choosing the correct option.

1. Principle of atomic spectroscopy _____. (CO1, K2)
 - (a) Refraction of light
 - (b) Scattering of light
 - (c) Absorption or emission of light by atoms
 - (d) Transmission of light
2. Which spectroscopic technique is commonly used to analyze the functional groups in organic Compounds? (CO1, K2)
 - (a) Fourier transform infrared spectroscopy
 - (b) Ultraviolet-visible spectroscopy
 - (c) Raman spectroscopy
 - (d) Ultraviolet photoelectron spectroscopy

3. What is the basic principle of potentiometry? (CO2, K2)
- (a) Measurement of current
 - (b) Measurement of voltage without current flow
 - (c) Measurement of resistance
 - (d) Measurement of impedance
4. Coulometry technique used for (CO2, K2)
- (a) Measuring the potential difference
 - (b) Measuring current at a constant potential
 - (c) Determining the mass of an analyte through electrolysis
 - (d) Monitoring changes in concentration over time
5. What is the principle of polarography? (CO3, K1)
- (a) Measurement of potential
 - (b) Measurement of current as a function of applied voltage
 - (c) Measurement of impedance
 - (d) Measurement of mass
6. Which technique is used for elemental analysis and chemical state determination? (CO3, K2)
- (a) XPS
 - (b) XRD
 - (c) AFM
 - (d) TEM

7. _____ technique is commonly used to measure a sample's weight changes as a function of temperature. (CO4, K2)
- (a) Differential Scanning Calorimetry (DSC)
 - (b) Auger Electron Spectroscopy (AES)
 - (c) BET Surface Area Analysis
 - (d) Thermo Gravimetric Analysis (TGA)
8. What is BET analysis used for (CO4, K1)
- (a) Determining mass changes
 - (b) Measuring heat capacity
 - (c) Calculating surface area of materials
 - (d) Determining crystal structure
9. Which method is used for the optical characterization of thin films? (CO5, K2)
- (a) Impedance spectroscopy
 - (b) Spectrophotometry
 - (c) Hall Effect
 - (d) DC resistivity
10. Multilayer thin film analysis is _____. (CO5, K1)
- (a) Surface capacitance
 - (b) Interfacial interactions and individual layer properties
 - (c) Hall coefficient measurement
 - (d) Relaxation time calculations

Part B

(5 × 5 = 25)

Answer **all** the questions not more than 500 words each.

11. (a) Explain the significance of ultraviolet-visible spectroscopy. (CO1, K3)

Or

- (b) Express the principle of flame emission spectroscopy. (CO1, K3)

12. (a) Give short notes on the working principle of potentiometry. (CO2, K2)

Or

- (b) Describe the working principles of impedance analysis. (CO2, K2)

13. (a) Summarize the principle of Scanning Electron Microscopy (SEM). (CO3, K3)

Or

- (b) Outline the working of Energy Dispersive X-ray Spectroscopy (EDAX). (CO3, K3)

14. (a) Express the detailed notes on Differential Thermal Analysis (DTA). (CO4, K2)

Or

- (b) Write a short note on Auger electron spectroscopy (AES) analysis. (CO4, K2)

15. (a) Explain the Hall Effect and its applications. (CO5, K4)

Or

- (b) Classify the multilayer thin film techniques. (CO5, K4)

Part C

(5 × 8 = 40)

Answer **all** the questions not more than 1000 words each.

16. (a) Explain in detail the principle, instrumentation, and applications of atomic absorption spectroscopy. (CO1, K3)

Or

- (b) Compare the atomic and molecular spectroscopy. (CO1, K3)

17. (a) Explain the construction and working of an electrochemical cell. (CO2, K2)

Or

- (b) Compare the potentiometry and voltammetry analysis with examples. (CO2, K2)

18. (a) Describe the principle, instrumentation, and applications of SEM with a neat sketch. (CO3, K3)

Or

- (b) Explain briefly the working principle of NMR with a neat diagram. (CO3, K3)

19. (a) Express the principle, instrumentation, and applications of Thermogravimetric analysis (TGA). (CO4, K2)

Or

- (b) Discuss the instrumentation and working of micro thermal analysis. (CO4, K2)

20. (a) How do you characterize a Transmission Electron Microscope (TEM) with a neat sketch. (CO5, K4)

Or

- (b) Brief about electrical characterization of thin films. (CO5, K4)
-

R3641

Sub. Code

540506

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2025

Third Semester

Energy Science

Elective : ENERGY AUDIT AND MANAGEMENT

(CBCS – 2022 onwards)

Time : 3 Hours

Maximum : 75 Marks

Part A

(10 × 1 = 10)

Answer **all** the following objective type questions by choosing the correct option.

1. What is the primary goal of energy management?
(CO1, K2)
 - (a) To increase energy consumption
 - (b) To reduce energy costs and improve efficiency
 - (c) To increase the size of energy sources
 - (d) To produce more energy

2. Why is energy auditing important for organizations?
(CO1, K2)
 - (a) To comply with environmental regulations
 - (b) To monitor energy use and reduce waste
 - (c) To increase energy production
 - (d) To limit energy tariffs

3. Which of the following is the correct sequence of steps in an energy audit methodology? (CO2, K2)
- (a) Data collection, analysis, recommendations, implementation
 - (b) Recommendations, data collection, analysis, implementation
 - (c) Implementation, analysis, recommendations and data collection
 - (d) Data collection, implementation, recommendations, analysis
4. In an energy audit, what is meant by “Energy Benchmarking”? (CO2, K2)
- (a) Comparing energy usage with industry standards or best practices
 - (b) Installing new energy systems
 - (c) Developing a new energy source
 - (d) Setting financial goals for energy savings
5. What is the first step in the energy planning process? (CO3, K4)
- (a) Identifying energy-saving opportunities
 - (b) Establishing energy performance indicators (EnPIs)
 - (c) Setting energy goals and objectives
 - (d) Implementing energy-saving measures
6. Which of the following is an example of a measurable objective in energy policy planning? (CO3, K4)
- (a) Reduce energy consumption by 15% over the next 3 years
 - (b) Increase energy consumption to meet production targets
 - (c) Build new power plants for energy generation
 - (d) Reduce energy audit costs

7. Which law of thermodynamics is primarily used in energy balance? (CO4, K3)
- (a) Zeroth Law
 - (b) First Law
 - (c) Second Law
 - (d) Third Law
8. What does MIS stand for? (CO4, K3)
- (a) Management Input System
 - (b) Management Information System
 - (c) Machine Integration System
 - (d) Marketing Information System
9. Which instrument is used to measure the electrical power of an appliance? (CO5, K2)
- (a) Lux meter
 - (b) Power analyzer
 - (c) Infrared thermometer
 - (d) Tachometer
10. What does a lux meter measure? (CO5, K2)
- (a) Power consumption, k, kz
 - (b) Light intensity
 - (c) Voltage fluctuations
 - (d) Airflow rate

Part B

(5 × 5 = 25)

Answer **all** the questions not more than 500 words each.

11. (a) Explain the general philosophy behind energy audit and management. (CO1, K2)

Or

- (b) Describe how sustainability and cost-effectiveness are integral principles of energy Management. (CO1, K2)

12. (a) Explain the main steps involved in an energy management approach. (CO2, K2)

Or

- (b) Describe the advantages of substituting conventional fuels with alternative energy sources. (CO2, K2)

13. (a) Explain the challenges faced in implementing an energy policy. (CO3, K4)

Or

- (b) What is the importance of energy policy planning for organizations? Explain with examples. (CO3, K4)

14. (a) How can an energy balance be integrated with an MIS for efficient energy management? (CO4, K3)

Or

- (b) Explain how MIS and energy balance together help in achieving energy efficiency. (CO4, K3)

15. (a) Elaborate the working principle and application of ultrasonic leak detectors in energy audits. (CO5, K2)

Or

- (b) What are the key instruments used for measuring electrical parameters in an energy audit? (CO5, K2)

Part C

(5 × 8 = 40)

Answer **all** the questions not more than 1000 words each.

16. (a) Explain the philosophy of energy audit and management. (CO1, K2)

Or

- (b) Define energy management. Explain the general principles of energy management and their role in achieving energy efficiency. (CO1, K2)

17. (a) Explain the need for energy audits in industries. (CO2, K2)

Or

- (b) Compare and contrast preliminary energy audits and detailed energy audits. (CO2, K2)

18. (a) Describe the process of energy policy planning and implementation. (CO3, K4)

Or

- (b) Discuss the role of energy policy planning and implementation in addressing environmental and economic challenges. (CO3, K4)

19. (a) Describe the process of preparing an energy balance. How does it help in improving energy efficiency? (CO4, K3)

Or

- (b) Explain how MIS contributes to effective decision-making in energy management. Provide examples. (CO4, K3)

20. (a) Discuss the importance of accuracy in energy audit instruments. Explain with examples of commonly used tools and their diagrams. (CO5, K3)

Or

- (b) List and explain the types of energy audit instruments used in measuring electrical, thermal and lighting parameters. (CO5, K3)
-