GUJARAT TECHNOLOGICAL UNIVERSITY

BE 6 SEMESTER – OLD PAPER – SUMMER 2022 TO SUMMER 2026 – QUESTION BANK

Subject Name & Code: Wind And Solar Energy - 3160917

Chapter 1: Physics of Wind Power

Repeated Questions:

1. Wind Turbine Terms, Betz Law and Power (Theory):

- **Q.** Define Cut in speed, Cut out speed and Tip speed ratio. **(WINTER 2022, 3 Marks; SUMMER 2023, 3 Marks; SUMMER 2025, 3 Marks)**
- **Q.** Write Betz Law and mention Betz limit value for wind turbine. **(WINTER 2022, 4 Marks; SUMMER 2023, 4 Marks; SUMMER 2024, 4 Marks; SUMMER 2025, 4 Marks)**
- **Q.** What is Betz limit? Explain significance / Derive Betz limit. **(WINTER 2023, 7 Marks - significance; WINTER 2024, 7 Marks - derivation)**
- **Q.** Derive an expression for power generation in wind turbine. **(SUMMER 2022, 7 Marks; SUMMER 2023, 7 Marks)**

2. Control and Types of Wind Turbines (Theory):

- **Q.** Explain stall and pitch control for wind power conversion system / Define Tip speed ratio, stall and pitch control. **(SUMMER 2022, 4 Marks; WINTER 2022, 4 Marks; WINTER 2023, 4 Marks; SUMMER 2024; SUMMER 2025, 4 Marks)**
- **Q.** Classify and explain Fixed and Variable speed wind turbines. **(SUMMER 2024, 3 Marks; SUMMER 2025, 7 Marks)**
- **Q.** Explain fixed speed wind turbine with neat sketch; mention advantages and disadvantages. [Diagram required – refer to the original question paper] **(WINTER 2022, 7 Marks; WINTER 2023, 3 Marks)**

Other Important Questions:

1. Wind Physics and Wind Power Scenario (Theory):

- **Q.** Define Tip Speed Ratio (TSR). **(WINTER 2023, 3 Marks)**
- **Q.** Explain the aerodynamic working principle of wind turbine. **(WINTER 2024, 4 Marks)**
- **Q.** Explain Wind Physics in detail. **(WINTER 2022, 3 Marks)**
- **Q.** Explain the available wind power scenario in India. **(SUMMER 2022, 3 Marks)**

2. Wind Turbine Classification, Layout and Power Curve (Theory):

- **Q.** Give detailed classification of wind turbine types and differentiate between them. **(WINTER 2025, 3 Marks)**
- **Q.** Compare horizontal axis and vertical axis wind turbines. **(WINTER 2024, 4 Marks)**
- **Q.** Draw the typical wind turbine power curve and show cut-in wind speed, rated wind speed, cut-out speed; explain significance of each. **(WINTER 2025, 4 Marks)**
- **Q.** With a neat diagram, draw the typical layout of a wind turbine power plant and explain the function of each component in brief. [Diagram required – refer to the original question paper] **(WINTER 2025, 7 Marks)**
- **Q.** Draw the curves showing wind velocity probability distribution function and wind velocity cumulative distribution function; differentiate features. **(WINTER 2025, 4 Marks)**

3. Wind Energy (Numerical):

- **Q.** Numerical: On a sunny day, probability of wind speeds 5 kmph = 0.4, 10 kmph = 0.4, 12 kmph = 0.1, 0 kmph = 0.1. Find average wind velocity using discrete wind histogram. **(WINTER 2025, 3 Marks)**
- **Q.** Numerical: Air density at 15 °C and 1 atm is 1.225 kg/m³; find air density at 30 °C. **(WINTER 2025, 3 Marks OR)**
- **Q.** Numerical: Calculate wind energy at 15 °C and 1 atm passing through 1 m² for: A. 100 h of 6 m/s winds; B. 50 h at 3 m/s plus 50 h at 9 m/s. **(WINTER 2025, 7 Marks OR)**

Chapter 2: Wind Generator Topologies

Repeated Questions:

1. Wind Generators (Theory):

- **Q.** List / classify types of generators used in wind power plant; write short notes on types of generators used in wind turbines. **(WINTER 2022, 3 Marks; SUMMER 2023, 3 Marks; WINTER 2023, 7 Marks; SUMMER 2025, 3 Marks)**
- **Q.** Explain construction and working of Doubly-Fed Induction Generators with characteristics. **(WINTER 2022, 7 Marks OR; SUMMER 2023, 7 Marks OR; SUMMER 2024, 7 Marks)**
- **Q.** Write short note on DFIG type of wind generator. **(WINTER 2023, 3 Marks; SUMMER 2025, 4 Marks)**

2. Variable Speed Systems and Power Electronic Converters (Theory):

- **Q.** Draw and explain variable speed wind energy conversion system. **(SUMMER 2022, 4 Marks; SUMMER 2023, 4 Marks)**
- **Q.** Explain converter control techniques in case of wind power. **(WINTER 2023, 4 Marks; SUMMER 2025, 7 Marks)**
- **Q.** Explain different power electronic converter technologies / role / types used in wind energy conversion system. **(WINTER 2023, 3 Marks; SUMMER 2024, 4 Marks; WINTER 2024, 7 Marks OR; WINTER 2025, 4 Marks)**

Other Important Questions:

1. Induction and Permanent Magnet Synchronous Generators (Theory):

- **Q.** What is an induction generator? Discuss its working and operating characteristics. **(WINTER 2024, 7 Marks)**
- **Q.** Draw the Torque–Speed characteristic of induction generator. **(SUMMER 2022, 3 Marks)**
- **Q.** List the advantages of Permanent Magnet Synchronous Generators (PMSG) for wind power. **(SUMMER 2024, 3 Marks)**
- **Q.** Draw the per phase model of PMSG; write its terminal per phase voltage expression. **(SUMMER 2022, 3 Marks)**

2. DFIG and Modern Technologies (Theory):

- **Q.** Explain power electronics converter used for doubly-fed induction generator with circuit diagram. [Diagram required – refer to the original question paper] **(SUMMER 2022, 7 Marks)**
- **Q.** Write short note on modern wind turbine technologies. **(SUMMER 2024, 7 Marks)**
- **Q.** Draw and explain the functionality of DFIG with partial scale frequency converter for application in wind turbine power plants. **(WINTER 2025, 7 Marks)**

Chapter 3: The Solar Resource

Repeated Questions:

1. Solar Angles and Air Mass (Theory):

- **Q.** Define: (i) Solar Azimuth Angle, (ii) Zenith Angle, (iii) Hour Angle. **(WINTER 2023, 3 Marks; SUMMER 2025, 3 Marks)**
- **Q.** Define: 1) Azimuth angle 2) Latitude angle 3) Longitude angle 4) Zenith angle. **(WINTER 2022, 4 Marks; WINTER 2024, 4 Marks)**
- **Q.** Define air mass and explain it. **(WINTER 2022, 3 Marks; SUMMER 2025, 3 Marks)**

2. Solar Energy Availability (Theory):

- **Q.** Explain the solar energy availability in India throughout the year. **(SUMMER 2022, 4 Marks; SUMMER 2023, 4 Marks)**

Other Important Questions:

1. Solar Geometry and Radiation (Theory):

- **Q.** Define zenith, solar altitude and azimuth angle in solar geometry. **(SUMMER 2023, 3 Marks)**
- **Q.** Define: i) Altitude angle ii) Zenith angle iii) Clearness Index. **(SUMMER 2024, 3 Marks)**
- **Q.** Define various solar angles and their effects on the collection of solar radiation on a tilted flat surface. **(SUMMER 2024, 7 Marks)**
- **Q.** Define earth–sun angle and observer–sun angle. **(SUMMER 2022, 3 Marks)**
- **Q.** Explain measurements of solar radiation. **(SUMMER 2024, 4 Marks)**
- **Q.** Classify solar radiation and define each term. **(WINTER 2022, 3 Marks)**
- **Q.** What is Solar Day Length? **(WINTER 2023, 3 Marks OR)**

2. Solar Resource (Numerical):

- **Q.** Numerical: What is the length of day on June 21 at Surat? (Surat location: 21.1702°N, 72.8311°E) **(WINTER 2024, 3 Marks)**
- **Q.** Numerical: Find extraterrestrial radiation on 31 March in W/m^2; take solar constant = 1367 W/m^2. **(WINTER 2025, 3 Marks OR)**
- **Q.** Numerical: Find optimum tilt angle for a south-facing PV module for latitude 32.1° at solar noon on March 1. **(WINTER 2025, 7 Marks OR)**

Chapter 4: Solar Photovoltaic

Repeated Questions:

1. PV Cell, Module and Characteristics (Theory):

- **Q.** Draw and explain I–V characteristic of a PV array. **(SUMMER 2022, 4 Marks; SUMMER 2023, 4 Marks)**
- **Q.** Explain power conversion in PV cell with circuit diagram. [Diagram required – refer to the original question paper] **(SUMMER 2022, 7 Marks OR; SUMMER 2023, 7 Marks)**
- **Q.** Explain / differentiate solar cell, module, panel and array. **(SUMMER 2022, 3 Marks; WINTER 2022, 3 Marks; SUMMER 2023, 7 Marks; WINTER 2023, 7 Marks; SUMMER 2025, 3 Marks OR; WINTER 2025, 3 Marks)**
- **Q.** Compare monocrystalline, polycrystalline and thin-film / amorphous solar modules / cells. **(SUMMER 2023, 3 Marks OR - polycrystalline vs thin film; SUMMER 2024, 7 Marks; WINTER 2025, 7 Marks OR)**
- **Q.** Draw and explain I–V and P–V characteristics of solar cell; define Fill Factor. **(WINTER 2022, 7 Marks; WINTER 2024, 3 Marks; SUMMER 2025, 7 Marks OR; WINTER 2025, 3 Marks)**

2. MPPT and Power Electronic Converters (Theory):

- **Q.** What is Maximum Power Point Tracking (MPPT) system? Explain P&O algorithm to track maximum power from solar PV system. **(WINTER 2022, 7 Marks; WINTER 2024, 7 Marks; SUMMER 2025, 7 Marks)**
- **Q.** What is Maximum Power Point Tracking (MPPT) system and which types of algorithms are used to track maximum power from solar PV system? / What is MPPT? **(SUMMER 2022, 7 Marks; SUMMER 2023, 7 Marks OR; SUMMER 2024, 3 Marks)**
- **Q.** Explain power electronics converter used in PV power system for maximum power extraction. **(SUMMER 2022, 7 Marks; SUMMER 2023, 7 Marks OR)**

3. PV Systems and Applications (Theory):

- **Q.** Differentiate Grid-Connected System and Standalone system. **(SUMMER 2023, 3 Marks; WINTER 2023, 4 Marks; SUMMER 2025, 4 Marks)**
- **Q.** Explain importance / working of solar water pump. **(SUMMER 2022, 4 Marks; WINTER 2022, 7 Marks; SUMMER 2023, 3 Marks OR; WINTER 2023, 4 Marks; WINTER 2023, 7 Marks; SUMMER 2025, 7 Marks OR)**
- **Q.** Draw and explain solar street light operation with circuit diagram / Write short note on solar street light. [Diagram required – refer to the original question paper] **(SUMMER 2022, 4 Marks; SUMMER 2023, 4 Marks OR; SUMMER 2024, 7 Marks)**
- **Q.** Write short note on battery sizing. **(WINTER 2022, 3 Marks; SUMMER 2025, 3 Marks)**
- **Q.** List advantage and limitation of Solar Energy. **(WINTER 2022, 4 Marks; SUMMER 2024, 4 Marks; SUMMER 2025, 4 Marks)**

Other Important Questions:

1. PV Cell Fundamentals (Theory):

- **Q.** Explain electrical circuit model of PV cell. **(SUMMER 2022, 7 Marks)**
- **Q.** Explain the process of electron–hole pair generation by photon absorption. **(WINTER 2025, 4 Marks)**
- **Q.** Explain application of bypass diodes in solar PV technology. **(WINTER 2025, 3 Marks OR)**
- **Q.** The I–V characteristics of two PV cells connected in series to deliver power to a load is shown; considering variation in load explain sourcing and sinking issue. [Diagram required – refer to the original question paper] **(WINTER 2024, 4 Marks)**

2. PV Systems, Applications and Battery (Theory):

- **Q.** Explain necessity of battery in PV based power system. **(SUMMER 2022, 3 Marks OR)**
- **Q.** Explain operation of grid connected solar PV system. **(WINTER 2022, 4 Marks)**
- **Q.** Explain working of standalone solar PV system. **(WINTER 2023, 7 Marks)**
- **Q.** What is Standalone solar system? Where can it be installed? **(SUMMER 2024, 3 Marks)**
- **Q.** Write applications of Solar PV Power. **(SUMMER 2024, 4 Marks)**
- **Q.** Elaborate applications of solar PV technology with necessary diagram: (i) Stand alone / off grid and (ii) Grid-interactive / grid tied. [Diagram required – refer to the original question paper] **(WINTER 2025, 7 Marks)**

3. Converters, MPPT and Control (Theory):

- **Q.** Is a buck converter capable of tracking the entire I–V characteristics of a PV panel? Justify your answer. **(WINTER 2024, 7 Marks OR)**
- **Q.** Draw the control block diagram of grid connected PV system controlled in d–q reference frame. [Diagram required – refer to the original question paper] **(WINTER 2024, 4 Marks)**
- **Q.** Draw the control block diagram of standalone PV system. [Diagram required – refer to the original question paper] **(WINTER 2024, 4 Marks OR)**
- **Q.** Draw and explain incremental conductance MPPT algorithm. **(WINTER 2024, 7 Marks OR)**

4. Solar PV (Numerical):

- **Q.** Numerical: For a PV module, V_{OC} = 36.72 V, temperature coefficient α_v = −0.34%/K. Calculate V_{OC} at 40 °C. **(WINTER 2024, 3 Marks)**
- **Q.** Numerical: A PV panel delivers maximum power 1 kW at 200 V; efficiency = 20%. Assuming standard conditions, find area in m². **(WINTER 2024, 3 Marks OR)**
- **Q.** Numerical: Battery sizing for a pumping-station PV system. Load-1: 50 W, 24 V light for 14 h at night; Load-2: 96 W, 24 V pump twice/day for 2 h each; Load-3: 40 W, 24 V fan for 24 h. Design battery size in Ah. Given: night load duration = 14 h, battery efficiency = 0.7, DOD = 60%, days of autonomy = 1, PV efficiency = 16%, H_{atmin} = 4.57 kWh/m²/day. **(WINTER 2024, 7 Marks)**
- **Q.** Numerical: PV module MPP at V_m = 30 V, I_m = 6 A. What duty cycle should be provided to a buck-boost converter if module is to deliver 12 V to charge a battery? How many amperes delivered? If ambient cools without change in insolation, should duty cycle be increased or decreased? **(WINTER 2025, 7 Marks)**

Chapter 5: Network Integration Issues

Repeated Questions:

1. Power Quality and Grid Code (Theory):

- **Q.** Describe / list / explain power quality issues during integration of solar–wind with grid. **(WINTER 2022, 4 Marks; SUMMER 2023, 4 Marks; SUMMER 2024, 4 Marks; SUMMER 2025, 3 Marks OR; WINTER 2025, 7 Marks - which issues are aggravated and why)**
- **Q.** What is grid code and why is it required? / Write grid code technical requirements for renewable energy integration. **(WINTER 2022, 3 Marks; SUMMER 2023, 4 Marks OR; WINTER 2023, 3 Marks; WINTER 2024, 3 Marks; SUMMER 2025, 4 Marks)**

2. Grid Disturbances and Hybrid Systems (Theory):

- **Q.** Explain PV and wind farm behavior during grid disturbances. **(SUMMER 2024, 7 Marks; WINTER 2025, 7 Marks)**
- **Q.** Explain modeling of elements in hybrid PV–wind system briefly. **(WINTER 2022, 7 Marks; SUMMER 2025, 7 Marks)**

Other Important Questions:

1. Integration Issues and Ride-Through (Theory):

- **Q.** What is voltage and frequency operating limits on integration of solar and wind system? **(SUMMER 2024, 3 Marks)**
- **Q.** State and explain any three network integration issues for solar and wind energy sources integration with grid. **(SUMMER 2022, 7 Marks)**
- **Q.** Explain fault ride-through for wind farms in brief. **(WINTER 2024, 3 Marks OR)**
- **Q.** Explain low voltage ride through capability. **(WINTER 2025, 4 Marks)**
- **Q.** What is flicker? How is the issue of flicker aggravated with usage of wind turbine power plants? **(WINTER 2025, 4 Marks)**
- **Q.** Draw the power generation by solar PV and wind turbine during 24 hours of a day. **(SUMMER 2022, 4 Marks)**

Chapter 6: Solar Thermal Systems

Repeated Questions:

1. Solar Collectors and Central Receiver (Theory):

- **Q.** What is solar collector? Explain its uses. **(SUMMER 2022, 3 Marks; SUMMER 2023, 3 Marks)**
- **Q.** Give / classify types of solar collectors / concentrators used in solar thermal plant. **(SUMMER 2023, 4 Marks; WINTER 2023, 7 Marks; SUMMER 2024, 3 Marks; WINTER 2024, 4 Marks)**
- **Q.** Classify solar thermal collectors; explain construction and working of solar flat plate collector. **(WINTER 2022, 7 Marks; SUMMER 2025, 7 Marks)**
- **Q.** Explain the concept of central receiver. **(WINTER 2022, 4 Marks; SUMMER 2025, 3 Marks OR)**

2. Solar Pond and Solar Cooker (Theory):

- **Q.** Explain operation / working of solar pond with its applications. **(SUMMER 2022, 7 Marks; SUMMER 2023, 7 Marks; WINTER 2023, 3 Marks; WINTER 2024, 7 Marks; WINTER 2025, 4 Marks)**
- **Q.** Explain operation / construction and working of solar cooker with usual diagram. [Diagram required – refer to the original question paper] **(SUMMER 2022, 3 Marks OR; SUMMER 2023, 3 Marks OR; WINTER 2023, 7 Marks; WINTER 2024, 3 Marks)**
- **Q.** Write short note on box type solar cooker. **(WINTER 2022, 4 Marks; SUMMER 2025, 4 Marks)**

3. Solar Thermal Applications (Theory):

- **Q.** List out applications of solar-thermal systems. **(WINTER 2022, 7 Marks; SUMMER 2023, 7 Marks OR; WINTER 2023, 4 Marks; SUMMER 2025, 7 Marks OR)**
- **Q.** Explain Solar Refrigeration and Air Conditioning / solar air conditioner. **(SUMMER 2022, 4 Marks; SUMMER 2023, 7 Marks; WINTER 2023, 7 Marks; SUMMER 2024, 7 Marks; WINTER 2024, 7 Marks; SUMMER 2025, 7 Marks)**
- **Q.** Explain solar water heater / solar water heating plant / solar heater. **(SUMMER 2022, 7 Marks; WINTER 2023, 4 Marks; SUMMER 2024, 4 Marks; WINTER 2024, 3 Marks OR)**
- **Q.** Explain solar passive heating and cooling system / passive solar cooling. **(WINTER 2022, 7 Marks; WINTER 2023, 4 Marks; WINTER 2024, 4 Marks OR; SUMMER 2025, 4 Marks; WINTER 2025, 4 Marks)**

Other Important Questions:

1. Solar Thermal Power Generation (Theory):

- **Q.** Explain working of Solar thermal power generation plant. **(SUMMER 2024, 7 Marks)**
- **Q.** Write short note on Solar thermal power generation technologies. **(WINTER 2023, 4 Marks)**
- **Q.** Draw the schematic layout of the Solar thermal power plant and classify the types of solar collector used in it. [Diagram required – refer to the original question paper] **(WINTER 2025, 3 Marks)**

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