SOLAR AND WIND ELECTRICAL SYSTEMS IMPORTANT QUESTIONS

UNIT 1

1. Define and explain the terms: (a) Irradiance (b) Irradiation (c) Insolation.

2. Define and explain the terms: (a) Extraterrestrial Radiation (b) Terrestrial Radiation (c) Solar constant (d) Air mass Ratio (with a relevant sketch)

3. Sketch the spectrum of radiation from sun available at the top of the atmosphere, at the sea level and compare it with that of a black body @5800

K. Identify the regions of UV, Visible and Infrared bands in the sketch.

4. Draw neatly the orbit of the earth around the sun depicting the two solstices, two equinoxes, and their dates of occurrence.

5. Assuming an Earth centric Solar system draw, define and explain the terms with the help of appropriate sketches: (a) Latitude **'L'** (b) Solar Declination angle **δ** (c) Altitude angle at Solar noon 'β_N' (d) Tilt angle (e)Hour angle.

6. Find the optimum tilt angle for a south-facing photovoltaic module in Delhi (Latitude of Delhi is 28.7^0N) at solar noon on 30^{th} June.

7. Explain the effects of Atmosphere on the Terrestrial Solar Radiation.

8. (a)Draw a sketch and explain the terms Altitude angle **'β'** and Azimuth angle '**φs**' of the sun and their importance.

(b) Find the altitude angle **'β'** and azimuth angle '**φs**' for the sun at 3:00 P.M. solar time in Hyderabad (Latitude of Hyderabad is 17.38^0), on summer solstice.

9. Explain the working of the following radiation measurement instruments (a) Pyranometer (b) Pyrheliometer.

10. Write short notes on (i) Mono crystalline and (ii) Poly crystalline Solar cells.

11.(a)Draw neatly a plot of the Photon energy as a function of its wavelength and show clearly the Energy wasted below & above the cutoff wavelengths and the usable energy for a Silicon Solar cell.

(b) Explain clearly why the energy is wasted both below and above the cutoff wavelengths highlighting the dependence on band gap energy of the particular material chosen for the solar cell.

12.(a) Explain the working principle of a solar cell

(b) Explain the construction of a solar cell with a neat figure

(c) Write down clearly all the important concepts of Solar cells.

UNIT 2

1. (a) Draw the equivalent circuit of a Solar cell and from that explain the terms **'Isc'** & **'Voc'**. Derive expressions for the current **'I'** delivered to a load & **'Voc'** in terms **'Isc'** and **'I_0'** (Reverse Saturation current). Using these expressions draw the Dark current and Light current versus V.

(b) Starting from these basic I-V curves and with additional curves explain what is Maximum Power Point and where it occurs.

2. Define and explain the terms: (i) Cell efficiency and (ii) Fill factor

3. Explain the effect of 'Irradiation' and 'Temperature' on the I-V characteristics of a solar cell.

4. (a)Explain clearly and in detail what MPPT is with the help of relevant diagrams.

5. (a) What are PV Modules and Arrays in Solar PV systems?

(b) Explain clearly with the help of suitable figures how the current and Voltage levels of PV modules are increased by interconnecting them.

6. (a) Mention what are the 'BOS' and explain briefly the important systems.

(b) Explain in detail the various criteria on which the Inverters can be classified for use in PV solar systems.

7. Explain briefly (i) Batteries (ii) Charge Controllers

8. (a)Explain the important features of 'Stand Alone Solar Power System'

(b) With the help of a suitable block diagram explain the operation of such a Standalone system with battery backup and other control features.

9. (a)Explain the important features of 'Grid Connected Solar Power System'

(b) With the help of a suitable block diagram explain the operation of such a System with battery backup and other Interface and Synchronization features.

10.(a) Explain briefly the concept of a Hybrid Solar System

(b) With the help of a simple Block diagram explain the operation of a PV - DG - Wind Hybrid system.

UNIT 3

1. Derive an expression for the Power contained in wind.

2. Derive an expression for the limit on efficiency in wind energy conversion (Derive an expression for "Betz limit "in wind energy conversion and explain in detail with relevant plot).

3. Define and explain the terms: Solidity, Rotor Swept Area, Tip speed ratio, Power Coefficient in wind energy systems.

4. Explain the following subsystems of a Wind Turbine: (a) Tower (b) Nacelle and the subsystems in side.

5. (a) From an understanding of the Power coefficient of wind turbine draw the Power-speed curves of a wind turbine and explain the same.

(b) Using a separate plot show the C_p versus TSR curves for different Pitch angles and explain the dependence of these curves on the Pitch angle.

(c) From the same concept that C_{Popt} always occurs at a definite value of λ say($= \lambda_{opt}$) derive an expression for P_{max} in terms of C_{Popt} & λ_{opt} and prove that P_{max} is proportinal to ω_3.

6. Explain with suitable plots the Torque speed characteristics of typical Propellor type wind turbines. Using the plots along with load-torque characteristics explain the importance of matching them with suitable proportionality constant K.

7. (a) Explain the need for the control systems in wind Turbines.
(b) Explain in detail the need and functioning of the following control systems in Horizontal Axis Wind Turbines. (i) Pitch angle control (ii) Stall control (iii) Yaw control
8. With the help of Typical Power versus wind speed characteristics of variable speed wind machines show and explain the different speed control regions and the strategy of control adopted in those regions.

UNIT 4

1. (a) Name and explain the four basic schemes of Electrical power generation with wind turbines.
(b) Elaborate in detail the advantages of Variable speed - constant frequency scheme.
2. (a) Explain the basic principle of operation of an Induction Generator showing the Torque –Speed Characteristic of an Induction Machine beyond the Synchronous speed.
(b) Explain step by step the process of self-excitation in a squirrel cage Induction Generator with capacitors on the stator side with the help of the open circuit magnetization curve and the capacitance lines.
(c) Highlight important concepts of Self Excitation in a Standalone Induction Generator along with a summary of qualitative relations.
3. Explain the limitations of Cage Rotor Induction Generator in standalone operation. (In self-excited mode)

4. Explain how the above limitations can be overcome to obtain DC power at a controllable voltage using Controlled firing angle scheme with ac-side capacitor from a Cage Rotor Induction Generator.

5. Explain with the help of a suitable block diagram the method to obtain DC power at a controllable voltage with DC-side capacitor from a (SCIG) Squirrel Cage Induction Generator.

6. Explain the operation of a fixed Speed Wind Turbine system with a single output Squirrel Cage Induction Generator with the help of a block diagram highlighting all the technical aspects, advantages and limitations.

7. (a) Explain the principle of operation of a Doubly Fed Induction Generator with the help of Power flow diagram and Block diagram.

(b) Explain clearly how a DFIG works satisfactorily in a variable speed Wind Turbine system over a wide speed range with the help of Torque speed Characteristics with both positive and negative slip regions showing the equivalent Rotor resistance variation.

8. Explain the Operation of a wound field Synchronous Generator in a variable- speed wind energy conversion scheme with control strategy based on ‘speed cube law’ to obtain optimal power output from the wind turbine.

9. (a) Explain the limitation of a Synchronous generator to get output at utility frequency by direct connection to the Turbine Rotor. Elaborate how this limitation is overcome with a Permanent Magnet Synchronous generator.

(b) Explain with simple sketches the constructional features of PMSGs.

10. (a) With the help of a simple phasor diagram of a PMSG derive the equations for steady state Power and Torque generated in such a Machine.

(b) Explain the operation of a PMSG in a variable-speed wind energy conversion scheme with the help of a suitable Block diagram.

11. (a) What are the important technical features and subsystems of a typical wind farm with several wind Power Generators colocated.

(b) Explain briefly the salient features of such a Wind Turbine with the help of a detailed block diagram.

(c) What are the interfacing requirements and the conditions for synchronizing of such a wind generator with the Grid?

12. Explain how active power & reactive power flow into a grid system from a wind energy system employing a PWM Inverter as final power output stage can be controlled with the help of a single phase equivalent circuit and the corresponding Phasor diagram.

13. Explain the effects of Wind Generator on the Grid with the help of a simple equivalent circuit and a Phasor diagram.

UNIT 5

1.explain about overview of grid code technical requirements of power system.

2.explain fault ride-through for wind farms for grid connected power system.

3.explain about real and reactive power regulation and voltage and frequency operating limits for grid connected power system.

4.explain solar pv and windfarm behavior during grid disturbances.

5.explain about power quality issues for grid connected renewable energy sources.

6.explain interconnection experiences in grid connected power system.

7.explain hybrid and isolated operations of solar pv and wind systems.