Master of Power Engineering 1st Year 2nd Semester– 2025

Subject: Advanced Renewable Energy Technologies (PG/POW/PE/T/124D)

Time: Three hours Full Marks for Part-I: 70

CO	PART-I (Use Separate answer script for each part)	Marks[70]
[1]	**Answer any *TEN* from this questions**	[2×10=20]
(a)	Briefly state the advantages of muti-junction solar cell over single junction solar cell.	
(b)	Name different policy & regulatory frame work of MNRE to promote Renewable energy in India.	
(c)	What are the key barriers for slow growth of renewable energy in transport sector globally?	
(d)	Draw a simple schematic diagram of heat pump using renewable energy for heating & cooling.	
(e)	Define internal & external quantum efficiency of solar cell.	
(f)	Define Energy Pay Back Time (EPBT) of a solar cell.	
(g)	What is solar desalination?	
(h)	What do you mean by solar district heating & cooling?	
(i)	What factors are being focused for performance analysis of renewable based smart grid system?	
(j)	Define Fault Ride Through (FRT) capability.	
(k)	Define Energy Exergy analysis of smart grid?	
(l)	What are the power quality issues in renewable energy integration in a smart grid?	
(m)	Briefly state the benefits of STATCOM over FACT devices for power quality improvement in a smart grid.	
(n)	Define Life Cycle Cost Analysis (LCCA) for renewable energy projects.	
(o)	State the basic components of grid connected solar & wind energy system with a basic schematic diagram.	
[2]	**Answer any *TWO* from this questions**	[20]
(a)	What are the recently developed 3rd generation solar cells? Briefly explain any two types.	2+4+4
(b)	What is Flash testing of solar panel? Briefly explain objective & methodology of flash testing.	2+8
(c)	What is the function of anti-reflection coating for crystalline silicon solar cell production? How diffusion helps formation of P-N junction in silicon solar cell?	5+5
(d)	Briefly explain solar assisted carbon capture & storage mentioning methodology & benefits.	(10)
[3]	**Answer any *TWO* from this questions**	[20]
(a)	Briefly explain the adverse environmental issues of fossil fuel energy those can be combated using renewable energy.	10
(b)	How does MPPT works? Briefly state the main features of MPPT solar charge controller with a schematic diagram.	5+4+1
(c)	Briefly explain with a schematic diagram distributed generation, smart grid using renewable energy.	8+2
(d)	Briefly explain basic concept of renewable energy integration into smart grid using IoT & ICT with a simple schematic diagram.	8+2
[4]	**Answer any *ONE* from this questions**	[10]
(a)	Design a 24 volt **solar photo voltaic energy system** by calculating the capacity of inverter, size of battery bank & size of solar photo voltaic array & sub-array. **Assume:** Total connected load is 15 KW & total system loading (energy) is 150kWhr/Day. **For inverter design-** Diversity factor of 85%, overall load Power factor is 0.80 & 100% standby mode. **For battery bank design- Assume:** 75% maximum occupancy, 7% inverter & 3% wiring loss, 4½ non sunny days, maximum depth of discharge (for longer life) is 73% & 2 Volt in each cell. **For module design- Assume:** battery energy efficiency 75%, module rating as nominal voltage is 12V, 35 Wp (Watt-peak) with full sun for 5 hours daily on average & 7½% loss in wiring in between array & battery along with battery regulator. In solar photo voltaic system design assume an array consists of a number of modules those are connected in series to form panels & a number of panels are connected in parallel to form sub-arrays.	10
(b)	For any solar thermal collector assume the following data: optical efficiency (γ)=0.85, incident solar radiation(q_{in})=850W/m^2, ambient temperature(T_a)=27^{0}C, heat loss co-efficient (U)=26 W/m^{2}K, collector efficiency factor(F')=1, receiver effective temperature (T)=85^{0}C, thermodynamic 1st law efficiency $\varepsilon_1=\varepsilon_2(1-T_a/T)$, & 2nd law efficiency ε_2=0.75, where receiver thermal output $Q_{out}=F'[\gamma.A_{in}.q_{in} - UA_{rec}(T-T_a)]$; $\gamma=[U.A_{rec}(T_{max}-T_a)/A_{in}.q_{in}]$; a) Find the stagnation temperature (T_{max}) & collector efficiency (ε_c) if concentration ratio ($CR=A_{in}/A_{rec}$) are 1 & 10; b) Find optimal temperature of receiver ($T=T_{opt}$) at which overall efficiency($\varepsilon=\varepsilon_c\varepsilon_1$) is maximum along with maximum efficiency(ε_{max}) for CR=10.	10

[Turn over

Ref. No.: Ex/PG/POW/PE/T/124D/2025

Master of Power Engineering 1st Year 2nd Semester Examination 2025

Subject: Advanced Renewable Energy Technologies

Time Three Hours Full Marks 100

PART II (30 Marks)

Q1. Answer any Five (CO2) (3x5=15)

1. How transient stability analysis is done for wind farm applications?
2. How reactive power compensation helps power evacuation in wind farm?
3. How unsteady loads and load reduction is controlled for smart rotor wind turbine?
4. What are the different embedded strategies for active twist control?
5. What are the different technical criteria for optimal operation condition of PHS?
6. What are the different governor control techniques?
7. What are the different dynamic stability studies connected in hydro governor?
8. What are the different control strategies for smart rotor wind turbine?

Q2. Answer any Five (CO3) (3x5=15)

1. What are the different situations through which a turbine blade can be deformed?
2. What are the different failure mechanisms for multi rotor wind turbine system?
3. What is the aero-elastic analysis of a wind turbine?
4. What are the different field tests connected to small hydro plants?
5. How are the uncertainties in measurement checked for a small head hydro turbine?
6. What are the cost elements of a small hydro project?
7. What are the different parameters connected for energy prediction with hydro turbine?
8. What are the different technological features of pumped hydro energy storage?