**B.E. POWER ENGINEERING FOURTH YEAR SECOND SEMESTER EXAMINATION 2024**

**DESIGN OF HYBRID ENERGY SYSTEMS**

Time: 3 Hrs.                                                                                         Full Marks: 100

| Question Number | | Marks |
|---|---|---|
| | **Unit-I**<br>**(Answer any _two_; Marks: 20)**<br>**(Q1-Q3 must be answered consecutively)** | |
| 1. | a) What is hybrid energy system and state its merits?<br>b) Model battery storage system used in Hybrid renewable energy systems. | 2+3<br>5 |
| 2. | a) Explain the wind speed variation with height.<br>b) What is wind power curve? Explain wind power curve with proper expressions and graph. | 4<br>2+4 |
| 3. | a) Write down the flow chart for Incremental Conductance based MPPT algorithm.<br>b) Briefly describe the Inverter Hysteresis Current Control with neat schematic. | 5<br>5 |
| | **Unit-II**<br>**(Answer any _two_; Marks: 20)**<br>**(Q4-Q6 must be answered consecutively)** | |
| 4. | What are the different types of ocean energy system? Enumerate the advantages and disadvantages of tidal energy. | 3+7 |
| 5. | Explain the operating cycle of a single barrage tidal power plant with neat schematic. | 10 |
| 6. | Derive the expression of power in waves. | 10 |
| | **Unit-III**<br>**(Answer any _two_; Marks: 40)**<br>**(Q7-Q9 must be answered consecutively)** | |
| 7. | a) Define following terms: i) CRF ii) LOLP<br>b) A wind turbine has an initial capital cost of $165,000, a replacement cost of $95,000, a lifetime of 20 years, and an operation and maintenance (O&M) cost of $5,000/yr. What is its annualized cost over a 25year project lifetime at an annual real interest rate of 6%? | 5<br>15 |
| 8. | a) Derive the expression for total solar cells area required to supply the load demand<br>b) A solar PV has a capital cost of $4000 a replacement cost of $3500, and a lifetime of 14 years. At the end of a 30-year project lifetime, what is its salvage value?<br>c) Find total PV power and numbers of Series and parallel connected PV panels for a 12V DC bus PV system designed for 5000Wh/day energy requirement. Consider followings: $\eta_{bat}$=95%; $\eta_{el}$=90%; $\eta_{dc}$=80%; $V_{oc}$=18V, Energy produced (worst) =300Wh/day/Panel and $P_{pv}$=150W. | 5<br>5<br>10 |
| 9. | A diesel generator has an initial capital cost of $80,000, a replacement cost of $60,000, and a lifetime of 6 years. Its cost of operation and maintenance (O&M) is $2,471/yr, and its fuel cost is | 20 |

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| | $34,969/yr. What is the net present cost of this generator? What will be the cost of energy for 25000-unit energy? Consider project lifetime of 25-year and an annual real interest rate of 6%.<br><br>**Unit-IV**<br>**(Answer any _two;_ Marks: 20)**<br>**(Q10-Q12 must be answered consecutively)** | | |
| 10. | a) What are the different deterministic features of energy storage systems (ESS)?<br>b) Compare the power and energy density of Li-ion batteries, fuel cell and super capacitors? | 5<br>5 | |
| 11. | a) Compare lithium-ion battery with solid-state battery<br>b) Briefly illustrate Superconducting Magnetic Energy Storage system | 5<br>5 | |
| 12. | Briefly demonstrate the power Management strategy for grid connected Photovoltaic/Wind Turbine/ Batteries based hybrid energy system. | 10 | |