Set #

Birla Institute of Technology and Science, Pilani
II Semester 2023-24 ME F420 Power Plant Engineering
Comprehensive Examinations 18/10/2023

Closed Book Time: 180 Minutes Maximum Marks: 80

Weightage:40%

Part A (10x2=20 Marks)

Q1) Nuclear power generation caters to hardly 2% of the total installed capacity of our country and less likely to increase further in the near future. It is most unlikely to have this as a source to meet our power demand in the future. List the reasons for unable to drive nuclear power in our country and possible solution. [2].

Q2) Why solar thermal power generation is not popular when compared to solar PV technology? Justify and suggest the way to make it a possible replacement for net zero carbon power generation. [2]

Q3) Why the specific coal consumption of the power plants using Indian coal is much higher than the imported coal? Justify the answer and suggest suitable ways to reduce it. [2]

Q4) Explain the role of pumped hydro power generation from the Demand Side Management (DSM) with a typical load duration curve in terms of adaptability and cost. [2]

Q5) Compare the off shore and on shore wind mill power generation in terms of cost, PLF and operational constraints.

Q6) Why Integrated Gasification and Combined Cycle [IGCC] is not popular in India despite having higher efficiency? [2]

Q7) Why the power plants operating close to the critical pressure cannot have natural circulation system in the water wall tubes? [2]

Q8) What is Organic Rankine cycle and when is this used? [2]

Q9) Which cost makes LCOE of diesel generator based power generation very high in India? Justify your answer.

Q10) "India is committed to have net zero emission target by 2070"-DST press release on September 2023. Suggest suitable way forward to achieve this. [2]

Part B (6x10=60 Marks)

Q11) It is proposed to install a wind mill of 6kW generation capacity in the roof top of a HIG house located in a windy area to cater to the partial electricity demand. This house consumes 5000units/month. Average wind velocity in the area is 15m/s with PLF of 60% and efficiency of the unit is 40%. Electricity tariff purchased from EB is Rs.9/kWh. If the installation cost of the unit is Rs.0.6L/kW. Find the following a) Reduction in units consumed from EB b) Cost saved per year c) Minimum time required to recover the initial investment d) Length of the blade required. [10]

Q12) Economizer of a power plant generating steam of 485kg/s with boiler and condenser pressure as 200bar and 50kPa. (Neglect pump work). The flue gas undergoes temperature drop from 600^{O}C to 450^{O}C in the economizer. The overall heat transfer coefficient of 80W/m^{2}K. The diameter of the tube is 50mm with the inlet velocity of water as 1m/s. Find the number of tubes and length of each tube? (Saturation temperature at 200bar and 50kPa is 365.8^{O}C and 81.33^{O}C respectively). [10]

Q13) A gas turbine power plant of 250MW capacity, operates with the maximum permissible temperature of 1250^{O}C and atmospheric temperature as 25^{O}C. Pressure ratio is 7. Taking Cpa=1kJ/kgK and Cpg=1.1kJ/kgK for gases with adiabtic index as 1.4 and 1.33 respectively. Find the fuel cost of electricty generation assuming cost of diesel as Rs.90/liter having density of 800kg/m^3. witrh calorific value of 43 500kJ/Kg. Isentropic efficiency of both compressor and turbine is 80%. [10]

Q14) Flow duration curve of a hypothetical river is a straight line starting at 0% time with flow rate of 1000m^3/s and ending with flow rate of 100m^3/s at 100% time in a year. It is proposed to assess the economic viability of the project for Np100 and Np50. Total area of the reservoir available is 81sqkm. Minimum head proposed is 30m for NP100. Find the following a) Height of the dam required for NP50. b) Potential Power available for Np100 and Np50 Assuming turbine efficiency of 65%. Cost per MW of installed capacity is for both NP50 and NP 100 can be taken as Rs.6Croes/MW and Rs2Crors/MW respectively. Revenue generated per unit of electricity is Rs.4. Take salvage value is 0 and life of the Power Plant is 120 years. Cost of O&M is Rs0.03/kWh. Which of the two options will you suggest to install? Justify your answer. (Neglect other costs) [10]

Q15) Pilani in Rajasthan receives 900W/m^2 of solar heat flux. It is proposed to install a solar thermal power generation using a flat plate collector to generate 3kW of power using organic Rankine cycle for a house having maximum efficiency of power cycle as 10%. The glass temperature and plate temperature are 50^{O}C and 90^{O}C respectively. Emissivity of the plate and glass are 0.9 and 0.6 respectively. Convective heat transfer coefficient between the plate and glass is 5W/m^{2}K.Find the number of collectors required to meet the proposed installed capacity. **[10]**

Q16) Find the LCOE of sub critical and super critical power plants respective from the given data and justify the need for supercritical technology and its implementation. Neglect the cost of man power. Take life and salvage value of both the power plants as 30 years and 20%. **[10]**

Plant	Fixd cost in Rs./MW	SCC kg/kWh	Installed capacity	I+I+T	Fuel cost INR	PLF	O&M Rs./kWh
Sub critical	6C	0.9	500MW	12%	2500	80	0.4
Super critical	9C	0.5	800MW	10%	2500	95	0.5