flow rate of water required for humidification. Draw the psychrometric duct & chart for the problem solved above and locate the temperatures at various points. Also assess the feasibility of replacing above system with steam (200kPa & 150°C) injection. **(15 marks)**

Problem 5: Draw a *T-s* diagram for a five stage irreversible Reaction Steam Turbine.

(5 marks)

Problem 6: Draw a velocity diagram for an **impulse stage** and identify all the angles. A big impulse turbine is to be constructed using multi-staging. The geometric details of the fourth stage of this turbine are; Inlet flow angle (Nozzle angle): 17°; Inlet angle of rotor blade: 30.5 °; Exit angle of rotor blade: 22 °. Properties of steam for the fourth stage: Stage Inlet: 400 °C & 10 MPa; Stage Exit: 8 MPa.

Compute (a) absolute velocity of steam leaving the stage, (b) stage work, (c) stage efficiency and (d) Height of the rotor blade to generate a stage power of 20 *MW*.

(15 marks)

Problem 7: Prove that the optimum value of axial induction factor of a wind turbine is 1/3.

(5 marks)

Problem 8: Draw a Standalone PV Water Pumping System with specifications of PV panels to run a 10kW pump.

(5 marks)

Problem 9: Prove that, it is possible to introduce a hydraulic turbine in a steam power plant using closed feed water heaters for regeneration. Following are the details of A CFWH in a supercritical plant: Bleed Pressure: 17.0 MPa; Condenser Pressure: 15 kPa; Flow rate of bleed steam: 10810 kg/h. Select a suitable hydraulic turbine and support your answer with a scientific reasoning.

(10 marks)

Department of Mechanical Engineering
Indian Institute of Technology New Delhi
II Semester -- 2017 – 2018

MEL 241 ENERGY SYSTEMS & TECHNOLOGIES

MAJOR EXAMINATION

Time: 60 min **Max. Marks: 70**

(Open Hand-written Notes Examination)

Problem 1: Enumerate important specifications of a centrifugal pump and define NPSH. **(5 marks)**

Problem 2: Explain the need for division of Super heater into many sub-systems in the design of steam generator. Use appropriate temperature diagrams and laws of thermodynamics to answer this question. **(5 marks)**

Problem 3: Carryout first law analysis of Photosynthesis process and calculate the amount of solar energy utilized during production of 10^6 tons of biomass.

Substance	State	h_f^0 (kJ/mol)
CO_2	gas	-393.5
water	liquid	-285.6
steam	vapour	-241.8
Glucose	Solid	-1274.5

(5 marks)

Problem 4: An air-conditioning system is to be designed for a process industry during winter out-door conditions:

Out-door conditions: 5 °C DBT & 30 % of RH.
Required Indoor conditions: 36 °C DBT & 60% of RH.
Amount of air circulated: 250 m^3/min.

The conditions are achieved first by heating and then by humidifying. Find (a) heating capacity of the coil (b) The mass