**UNIT - I steam nozzles**

1. The inlet condition of steam nozzle is 10 bar and 2500 C. The exit pressure is 2 bar. Assuming isentropic expansion and negligible inlet velocity, determine the (i) throat area, (ii) exit velocity and (iii) exit area of the nozzle for a flow rate of 0.2 kg/s.
2. Dry saturated steam at 2.8 bar is expanded through a convergent nozzle to 1.7 bar. The exit area is 3 cm2. Calculated the exit velocity and mass flow rate for (i) isentropic expansion and (ii) supersaturated flow.
3. A convergent- divergent adiabatic steam nozzle is supplied with steam at 10 bar and 2500 C. The discharge pressure is 1.2 bar. Assuming that the nozzle efficiency is 100% and initial velocity of steam is 50m/s, find the discharge velocity.
4. Dry saturated steam at a pressure of 11 bar enters a convergent-divergent nozzle and leaves at a pressure of 2 bar. If the flow is adiabatic and frictionless, determine the:
5. Exit velocity of steam
6. Ratio of cross-section of exit and that at throat.
7. Dry saturated steam at a pressure of 8 bar enters a convergent divergent nozzle and leaves it at a pressure of 1.5 bar. If the flow is isentropic and if the corresponding expansion index is 1.33, find the ratio of cross-sectional area at exit and throat for maximum discharge.
8. Dry saturated steam at 3.5 bar is supplied to a convergent divergent nozzle whose throat area is 4.4 cm2 .The exit pressure is 1.1 bar. Determine the maximum possible discharge through nozzle per minute and area of nozzle at exit when the flow is maximum. Assume the flow as frictionless adiabatic.
9. Air at a pressure of 20 bar and at a temperature of 18°C is supplied to a convergent divergent nozzle having a throat diameter of 1.25 cm and discharging to atmosphere. The adiabatic index for air is 1.4 and the characteristic constant is 287. Find the weight of air discharged per minute.
10. Derive an expression for maximum discharge through convergent divergent nozzle for steam.
11. Steam enters a group of CD nozzles at 21 bars and 270℃. The discharge pressure of the nozzle is 0.07 bars. The expansion is equilibrium throughout and the loss of friction in convergent portion of the nozzle is negligible, but the loss by friction in the divergent section of the nozzle is equivalent to 10% of the enthalpy drop available in that section. Calculate the throat and exit area to discharge 14 kg/sec of steam.

1. Steam initially dry and saturated is expanded in a nozzle from 15 bar 300°C at 1 bar. if the friction loss in the nozzle is 12% of the total head drop calculate the mass of steam discharged when exit diameter of the nozzle is 15 mm.
2. Define critical pressure ratio of a nozzle and discuss why attainment of sonic velocity determines the maximum mass rate of flow through steam nozzle.
3. Air enters a frictionless adiabatic converging nozzle at 10 bar 500 K with negligible velocity. The nozzle discharges to a region at 2 bar. If the exit area of the nozzle is 2.5 cm2, find the flow rate of air through the nozzle. Assume for air Cp = 1005 J/kg K and Cv= 718 J/kg K.
4. A convergent divergent adiabatic steam nozzle is supplied with steam at 10 bar and 250°c.the discharge pressure is 1.2 bar.assuming that the nozzle efficiency is 100% and initial velocity of steam is 50 m/s. find the discharge velocity.

**Unit - ii boilers**

1. Explain the Loffler boiler with clear diagram.
2. Explain the Benson boiler and Lamont boiler.

**Unit - iii steam turbines**

1. The blade speed of a single ring impulse blading is 300 m/s and nozzle angle is 200. The heat drop is 625 KJ/kg and nozzle efficiency is 0.85. The blade discharge angle 300 and the machine develops 30 KW, when consuming 300 kg of steam per hour. Draw the velocity diagram and calculate the: 1) axial thrust on the blading and 2) heat equivalent per kg of steam friction of the blading.
2. The velocity of steam leaving the nozzle of an impulse turbine is 1000 m/s and the nozzle angle is 200. The blade velocity is 350 m/s and the blade velocity of coefficient is 0.85. assuming no of losses due to shock at inlet calculate for a mass flow of 1.5 kg/s and symmetrical blading (a) blade inlet angle (b) driving force on the wheel (c) axial thrust on the wheel and (d) power developed by the turbine.
3. In a certain stage of an impulse turbine, the nozzle angle is 200 with the plane of the wheel. The mean diameter of the blading is 3 m. it develops 50 KW at 2500 rpm. Five nozzles, each of 10 mm diameters expands steam isentropically from 15 bar and 2500 C to 0.5 bar. The axial thrust is 3 N. calculate the 1) blade angle at entrance and exit and 2) power lost in blade friction.
4. The steam supply to an impulse turbine with a single row of moving blade is 3 kg/s. the turbine develops 150 KW , the blade velocity is being 150m/s. the steam flows from a nozzle with a velocity of 450 m/s and the coefficient of velocity of blade is 0.95. find the nozzle angle , blade angle at entry and exit if the steam flows axially after passing over the blades.
5. In a single stage impulse turbine, the blade angles are equal and nozzle angle is 250. The velocity coefficient for the blade is 0.95.fint the maximum blade efficiency. If the actual blade efficiency is 85% of maximum blade efficiency, find the possible ratio of blade speed of steam speed.
6. Steam enters the blade row of an impulse turbine with a velocity of 500 m/s at an angle of 300 to the plane of rotation of the blades. The mean blade speed is 280 m/s. the blade angle on the exit side is 350. The blade friction coefficient is 12% loss. Determine the
7. Blade angle at inlet
8. Work done per kg of stream
9. Diagram efficiency
10. Axial thrust per kg of steam per second.
11. A steam jet enters the row of blades with a velocity of 350 m/s at an angle is of 200 with the direction of motion of moving blades. The velocity of steam passing over the blades is reduced by 10%. If the blade speed is 200 m/s, find the suitable inlet and outlet blade angle assuming that there is no thrust on blades. Also determine the power developed by the turbine per kg of steam flowing over the blades per second.
12. 300kg/min of steam (2 bar, 0.08 dry) flows through a given stage of reaction turbine. The exit angles of fixed blades as well as moving blades are 200 and 3.68 kw of power is developed. If the rotor speed is 360rpm and tip leakage is 5%, calculate the mean drum diameter and the blade height .the axial flow velocity is 0.8 times the blade velocity.
13. Describe briefly the various methods of steam turbine governing.

**UNIT IV COGENERATION AND RESIDUAL HEAT RECOVERY**

**UNIT V REFRIGERATION AND AIR CONDITIONING**

1. Air conditioning plant is required to supply 50 m3 of air per minute at a DBT of 22 0c and 50% RH. The atmospheric condition is 320c with 65% RH. Determine the mass of moisture removed and capacity of cooling coil if the required is obtained by dehumidification and sensible cooling process. Also calculate the sensible heat factor.
2. The air enters a duct at 100C and 80% RH at the rate of 150 m3/min and is heated to 300C without adding or removing any moisture. The pressure remains constant at 1 bar. Determine the RH of air at exit from the duct and rate of heat transfer.
3. It is required to design an air conditioning system for an industrial process for the following hot and wet summer conditions.

Outdoor conditions = 150C DBT and 10oC WBT

Required air inlet conditions = 200C DBT and 50% of RH

Amount of free air circulated = 0.25 m3/min, (each person)

Sealing capacity = 50 persons

The required condition is achieved by first by heating and then by adiabatic humidification. Calculate the following (i) capacity of heating coil in kw.(ii) capacity of humidifier.

1. An air water vapour mixture at 200c and 50% RH at a pressure of 1.013 bar is heated at constant pressure to a temperature of 35 0c.calculate the initial and final specific humidity, final relative humidity, dew point temperature, heat transferred per kg of dry air.
2. Air at 160c and 25% RH passes through a heater and then through a humidifier to reach the final DBT of 300c and 50% RH. Calculate the heat and moisture added to the air. What is the sensible heat factor?