Code No: R31034

R10

Set No: 1

III B.Tech. I Semester Supplementary Examinations, May 2013
THERMAL ENGINEERING-II
(Common to Mechanical Engineering & Auto Mobile Engineering)

Time: 3 Hours   **Max Marks: 75**

Answer any FIVE Questions

All Questions carry equal marks

Note: Use of steam tables and Mollier chart may be permitted.

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1. (a) Explain the concept of mean temperature of heat addition.
    (b) Steam at 28 bar and 50^0 C super heat is passed through a turbine and expanded to a pressure where the steam is dry and saturated. it is then reheated at constant pressure to its original temperature and then expanded to the condenser pressure of 0.2 bar. The expansion being isentropic, find   (i) Work done per kg of steam.
                                    (ii) Thermal Efficiency with and without reheat.

2. (a) With a neat sketch explain the working of Cornish boiler.
    (b) What is the function of fusible plug and where it is located in the boiler assembly?

3. (a) Derive the expression for critical pressure ratio. What is the significance of critical pressure ratio?
    (b) The nozzles of a steam turbine are supplied with dry saturated steam at a pressure of 9 bar. The pressure at exit is 1 bar. The turbine has 3-nozzles with a throat diameter 5 mm. The nozzle efficiency is 90% and turbine efficiency is 45%. Find the mass of steam used/hour and power developed.

4. (a) What are the differences between impulse and reaction turbines? Enumerate.
    (b) In a De-laval steam turbine, steam issues from a nozzle with a velocity of 1200 m/s. The nozzle angle is 20^0 and blade velocity is 400 m/s. The inlet and outlet blade angles are equal. Mass of steam flowing through the turbine is 850 kg/hr. Blade velocity coefficient is 0.8.
    Determine   i) Angles of blade
                           ii) Relative velocity of steam entering the blade.
                           iii) Tangential force on blades
                           iv) Power developed
                           v) Blade efficiency

5. In a parson's reaction turbine, mean blade speed is 60m/s. Inlet conditions of steam are 3 bar and 200^0 C. For the fixed and moving blades, inlet angle is 20^0. Determine

    (a) Blade height if blade height is $\dfrac{1}{10}$ of mean blade ring diameter.

    (b) Power developed by pair of fixed and moving blade rings
    (c) Heat drop required by the pair if steam expands with an efficiency of 0.80.
    Steam flow rate is 8 kg/sec.

6. (a) What are the functions of steam condensers in steam power plant? Justify the necessity.
    (b) Compare jet and surface condensers.

7. (a) Explain working of open cycle gas turbine with neat sketches of lay out & T-s plots.
    (b) What are the variables that effect efficiency of gas turbine cycle?

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8. (a) Write a detailed classification of propulsive devices.
    (b) Explain working of turbo prop engine with a neat sketch.
    (c) What are the various applications of rockets?

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Set No: 2

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Time: 3 Hours   **Max Marks: 75**
Answer any FIVE Questions
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1. (a) Draw the lay out, p-v & T-s diagrams of Rankine cycle and explain working in detail.
    (b) Define adiabatic flame temperature.

2. (a) Define equivalent evaporation and boiler efficiency
    (b) Explain all the 3-types of mechanical draught systems with neat sketches.

3. (a) Derive the equation which provides criteria to decide nozzle shape.
    (b) Steam enters a group of nozzles of a steam turbine at 12 bar and 220^0 C and leaves at 1.2 bar. The turbine develops 150 kW with specific steam consumption of 12 kg/kW-hr. If diameter of nozzles at throat is 10 mm; calculate the number of nozzles.

4. (a) Draw velocity triangles of an impulse turbine and derive expressions for
        (i) Force on rotor
        (ii) Work done on blade
        (iii) Power developed
        (iv) Axial thrust on rotor
    (b) Derive the expression for blading or diagram efficiency.

5. (a) Write a note on state point locus and reheat factor.
    (b) In a stage of impulse reaction turbine operating with 50% degree of reaction, the blades are identical in shape. The outlet angle of moving blades is 19^0 and the absolute discharge velocity of steam is 100 m/s in direction at 100^0 to the motion of blades. If the rate of flow of steam through the turbine is 15000 kg/hr calculate power developed by the turbine.

6. (a) With a neat sketch explain working of evaporative condenser
    (b) What are the various sources of air leakage into the condenser? And what are the effects of air?

7. In a gas turbine cycle, the pressure ratio is 6 and maximum cycle temperature is 650^0 C. The efficiencies turbine and compressors are 0.85 and 0.82. Air enters the compressor at 15^0 C and flow rate of air is 12kg/sec. For compression process, c_p=1.005 kJ/kg-K; γ=1.32. For combustion process, c_p=1.11 kJ/kg-K. Determine (a) Power developed
                                                                                   (b) Thermal Efficiency.
                                                                                   (c) Work ratio.

8. (a) Explain liquid propellant rocket with a neat sketch.
    (b) What are the various thrust augmentation techniques used in turbo-jet engine?
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Set No: 3

III B.Tech. I Semester Supplementary Examinations, May 2013
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Time: 3 Hours   **Max Marks: 75**

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1. (a) What are the methods to improve performance of Rankine cycle? Explain reheating in detail.
   (b) A steam turbine consumes 9 kg/kW-hr when steam is supplied at a pressure of 10 bar and at 400^0. The exhaust takes place at 0.1 bar. Compare the efficiency of the engine with the Rankine efficiency.

2. (a) Enumerate the differences between fire tube and water tube boilers.
   (b) Derive the condition for maximum discharge through the chimney.

3. (a) Derive the expression for maximum discharge through a convergent divergent nozzle.
   (b) In a steam turbine power plant, 5 kg of steam is supplied at 30 bar and 350^0 C to a group of nozzles. The exit pressure is 4 bar. Determine:
       (i) Dimensions of rectangular nozzle if *l/d is 3:1*
       (ii) Degree of under cooling
       (iii) Degree of super saturation
       (iv) Loss in enthalpy drop.

4. In a single stage impulse turbine isentropic heat drop in the nozzle is 251 kJ/kg; nozzle efficiency is 90%, nozzle angle is 20^0, ratio blade speed to whirl component of steam speed is 0.5, blade velocity coefficient is 0.9, absolute velocity of steam entering the nozzle=20 m/s. The steam flow rate 10 kg/sec. the steam leaves the blades axially. Determine :
       (i) blade angles at inlet and outlet
       (ii) blade efficiency
       (iii) power developed
       (iv) axial thrust

5. (a) Write a note on degree of reaction.
   (b) A 50% reaction turbine stage running at 3000 rpm the exit angles are 30^0 and the inlet angles are 50^0. The mean diameter is 1 m. The steam flow rate is 10000kg/min, stage efficiency is 85%.

6. (a) With a neat sketch explain working of ejector condenser.
   (b) What are the requirements of a good condenser/

7. In an open cycle gas turbine plant, air enters at 1.5 bar and 25^0 C and leaves the compressor at 5.5 bar. Maximum cycle temperature is 675^0 C, pressure loss in the combustion chamber is 0.2 bar. Efficiency of compressor is 0.85, turbine is 0.80, combustion is 0.90, r=1.4 and c_p=1.022 kJ/kg K for air and flue gases. Neglecting mass of fuel, Determine:
   (a) Quantity of air circulation if power developed is 1050 kW.
   (b) Heat supplied per kg of air.
   (c) Thermal efficiency of the cycle.

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8. In a turbojet, air is compressed in an axial compressor at inlet conditions of 1 bar and 10^0 C 3.5 bar. The final temperature is 1.25 times that for isentropic compression. The temperature of gases at inlet to turbine is 480^0 C. The exhaust gases from turbine are expanded in a velocity of approach is negligible and expansion may be taken to be isentropic in both turbine and nozzle. Value of gas constant R and index r are same for air and flue gases. Determine
    (a) Power required to drive the compressor per kg of air/sec
    (b) Air-fuel ratio if the calorific value of fuel is 42,000 kJ/kg
    (c) Thrust developed / kg of air / sec.

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1. (a) Explain regeneration cycle with the help of neat sketches of layout, p-v and T-s plots.
   (b) Derive expressions for mass flow rates of bled steam considering 2- bleedings.

2. (a) What are the advantages of preheating boiler feed water.
   (b) 5400 kg of steam is produced per hour at a pressure of 750 kN/m^2 , in a boiler when feed water temperature is 41^0 C. The dryness fraction of steam at exit is 0.98. The amount of coal burnt per hour is 670 kg of calorific value 31000 kJ/kg. Determine the boiler efficiency and equivalent evaporation.

3. (a) Explain the phenomenon of meta stable flow of through nozzle. What is the significance of Wilson's line in it?
   (b) Saturated steam at a pressure of 10 bar expands in a nozzle to pressure of 4 bar isentropically. If saturated flow occurs throughout determine:
       (i) Loss in enthalpy drop.
       (ii) Degree of under cooling
       (iii) Degree of super saturation

4. (a) What is compounding of turbines? Discuss in brief
   (b) In an impulse turbine, mean diameter of blades is 1.05m and the speed is 3000 rpm. The nozzle angle is 18^0, the ratio of blade speed to steam speed is 0.42 and blade velocity coefficient is 0.85. The outlet blade angle is 3^0 less than that of the inlet blade angle. Steam flow rate is 20kg/sec. Obtain:
       (i) Tangential thrust on blades
       (ii) Axial thrust on blades
       (iii) Resultant thrust
       (iv) Power developed
       (v) Blade efficiency

5. (a) With a neat sketch explain working of reaction turbine and draw velocity triangles.
   (b) Derive the expression for degree of reaction and show that inlet and outlet velocity triangles are symmetrical for a 50% degree of reaction turbine.

6. (a) Explain the working of surface condenser with a neat sketch.
   (b) Explain how quantity of cooling water in a condenser is estimated.

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7. In a gas turbine plant, air is drawn at 1 bar, 15^0 C and the pressure ratio is 6. The expansion takes place in two turbines. The efficiency of compressor is 0.82, high pressure turbine is 0.85 and low pressure turbine is 0.84. The maximum cycle temperature is 625^0 C. Calculate
   (a) Pressure and temperature of gases entering the low pressure turbine.
   (b) Net power developed
   (c) Work ratio
   (d) Thermal efficiency.
   Work output of high pressure turbine is equal to compressor work.

8. (a) Write a detailed classification of rockets.
   (b) In a jet propulsion unit, initial pressure and temperature to the compressor are 1.0 bar and 10^0C. The speed of the unit is 200m/s. The pressure and temperature of the gases before entering the turbine are 750^0 Cand 3 bar. Isentropic efficiencies of compressor andturbine are 85% and 80%. The static back pressure of the nozzle is 0.5 bar and efficiency of the nozzle is 90%. Determine   (a) Power consumed by compressor per kg of air.
                   (b)Air-fuel ratio if calorific value of fuel is 35,000 kJ/kg.
                   (c) Pressure of gas leaving the turbine.
                   (d)Thrust per kg ofair/sec
   C_p of gases=1.12 kJ/kg K, C_p of air=1.005 kJ/kg K, γ=1.4 for air, γ=1.32 for gases.

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