Code No: 07A60303 **R07** **Set No. 2**

III B.Tech II Semester Examinations,December 2010
THERMAL ENGINEERING - II
Mechanical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) What are the advantages of Gas turbines over steam turbines?
   (b) With the help of a schematic, explain the working of a regenerative gas turbine cycle and represent the processes on T-s diagram. [8+8]

2. Show that for maximum diagram efficiency of a reaction turbine the blade steam speed ratio is equal to cos α where α is the angle of absolute velocity at inlet. State the assumption made. Hence derive an expression for maximum efficiency. [16]

3. (a) Derive the expression for velocity and mass flow rate in a nozzle.
   (b) Define degree of undercoding nad degree of super saturation. [12+4]

4. The following observations were noted during the trial of a Surface Condenser:

   Condenser Vacuum = 70 cm of Hg
   Barometer reading = 76.5 cm oh Hg
   Condenser temperature = 35^0C
   Hot well temperature = 28^0C
   Condensate mass flow rate = 1800 kg/hr
   Air leakage = 1 kg/ 1000 kg of condensate
   Quantity of cooling water = 80,000 kg/hr
   Rise in temperature of cooling water = 12^0C
   Inlet temperature of cooling water = 15^0C

   Find

   (a) Vacuum efficiency,
   (b) Condenser efficiency,
   (c) Quality of steam entering the condenser and
   (d) Mass of air per m3 of condenser volume and mass of air per kg of uncondensed steam. [16]

5. A simple Rankine cycle works between pressures 28 bar and 0.06 bar, the initial condition of steam being dry saturated. Calculate the cycle efficiency, work ratio and specific steam consumption. [16]

6. Describe briefly the advantages of incorporating an eonomiser,air-preheater and Superheater in a steam boiler. Indicate the position of these in the passage of flue gases by a line diagram. [16]

7. Air enters a jet propulsion engine at the rate of 2100 kg/min at 15^0C and 1 bar and is compressed adiabatically to 4 times the entry pressure and to a temperature of 180^0C. The products of combustion enter the turbine at 815^0C and then enter the tail nozzle at 650^0C. Neglecting the ram effect and the mass of the fuel, assuming that the isentropic efficiency of compressor and turbine to be same and nozzle efficiency as 90%, find:

   (a) The isentropic efficiency of turbine and compressor.

   (b) Power required to drive the compressor.

   (c) Exit speed of gases.

   (d) Thrust created when flying at 800 kg/hr. [16]

8. In a reaction turbine, steam enters the blade pair at 1.5 bar and dryness fraction of 0.95. The discharge angles of both fixed and moving blades are 20^0 and the axial velocity of the steam is 0.7 of the blade velocity. The blade height is 15 cm, the mean diameter of the blade ring is 1.83 m and the turbine speed is 500 RPM. Compute the power developed and estimate the pressure drop through the blade pair if the efficiency is 75%. [16]

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Code No: 07A60303 **R07** **Set No. 4**

III B.Tech II Semester Examinations,December 2010
THERMAL ENGINEERING - II
Mechanical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Explain the effect of friction on the flow through a steam nozzle with the help of T-S diagram.
   (b) Explain what is meant by critical pressure ratio of nozzle. [12+4]

2. In a reaction turbine, the blade speed is 150 m/s and the ratio of blade speed to the steam speed is 0.625. The outlet angles of fixed and moving blades are 20^0 and 30^0 respectively. Calculate the degree of reaction, the adiabatic enthalpy drop in the pair of blade rings and the stage turbine.
   The specific volume of steam at fixed blade outlet is 0.567 m^3 and at the moving blade outlet is 0.6 m^3. Assume the efficiency of blades when considered as nozzles as 0.9 and the blade velocity coefficient as 0.86. [16]

3. In a regenerator gas turbine cycle, air enters the compressor at a temperature of 30^0C and pressure of 1.5 bar and discharges at 220^0C and 5.2 bar. After passing through the regenerator, the air temperature is 395^0C. The temperature of air entering and leaving gas turbine are 900^0C and 510^0C. Assuming no pressure drop through the regenerator, determine
   (a) The output per kg of air,
   (b) Efficiency of cycle and
   (c) Work required to drive the compressor. [16]

4. Describe the different operations of Rankine cycle. Derive also the expression for its efficiency. [16]

5. With the help of schematic diagram, explain the function of Turboprop engine. Represent the ideal cycle on T-s chart. Also list its advantages and applications. [16]

6. Define the term 'degree of reaction' as applied to a steam turbine. Show that the Parson's reaction turbine the degree of reaction is 50%. [16]

7. A boiler is equipped with a chimney of 30.48 m height. Atmospheric conditions are 755 mm of Hg and 35^0C. Average temperature of fuel gases in the chimney is 300^0C. If the boiler is supplied with 20 kg of air kg of fuel,
   calculate theoretical draught created in mm of H_2O.Take standard atmospheric pressure as 760 mm of Hg. [16]

8. For checking the air leakage into the condenser, the steam plant is run until conditions are steady and immediately steam supply to the engine is shutoff and the condensate extraction pumps are closed down. With the condenser being isolated, the temperature and the vacuum in the condenser are observed to be 42^0C and 680 mm of Hg. After 10 minutes, the values are observed to be 30^0C and 510 mm of Hg. The barometer reads 756 mm of Hg. The effective volume of the condenser is 0.4 m^3. Determine

   (a) The amount of air leakage into condenser during the observed period and

   (b) The mass of water vapor condensed in the same period. [16]

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Code No: 07A60303 **R07** **Set No. 1**

III B.Tech II Semester Examinations,December 2010
THERMAL ENGINEERING - II
Mechanical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. A closed cycle gas turbine with reheat operates with helium as working medium. The pressure ratio is 10. The maximum permitted temperature is 1000 K. Assuming the work output to be maximum, calculate the efficiency. If air is used instead of helium, calculate the efficiency and difference in heat added. Assuming ideal Brayton cycle, consider the temperature at the inlet of compressor as 27^0C. C_p of helium = 5.204 kJ/kgK and γ for helium is 1.6l7. [16]

2. (a) Derive the expression of critical pressure ratio for the maximum discharge through a nozzle.
   (b) What are the effects of super saturation on discharge and heat drop? [8+8]

3. (a) What are the differences between air breathing and rocket propulsion systems?
   (b) With the help of a neat diagram, explain the function of Solid propellant rocket engine. [8+8]

4. In a steam turbine steam at 20 bar, 360^0C is expanded to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. Assume ideal processes; find per kg of steam the net work and the cycle efficiency. [16]

5. At a particular stage of a reaction turbine, the mean blade speed is 160 m/s and the steam is at a pressure of 3.5 bar and 175^0C. The fixed and moving blades have inlet angle of 30^0 and exit angle of 60^0 . The blade height is 0.1 times the rotor diameter. The steam flow is 13.5 kg/s. Determine:
   (a) Blade height
   (b) Power develooped by the stage
   (c) Specific enthalpy drop if the stage efficiency is 85%. [16]

6. The following observations were noted during the trial of a Surface Condenser:
   Condenser Vacuum = 71 cm of Hg
   Barometer reading = 76.5 cm oh Hg
   Condenser temperature = 34^0C
   Hot well temperature = 28.5^0C
   Condensate mass flow rate = 1800 kg/hr
   Air leakage = 1 kg/ 1000 kg of condensate
   Quantity of cooling water = 57,500 kg/hr
   Inlet temperature of cooling water = 8.5^0C

Outlet temperature of cooling water = 26^0C
Find

(a) Vacuum efficiency,

(b) Condenser efficiency,

(c) Quality of steam entering the condenser and

(d) Mass of air per m^3 of condenser volume and mass of air per kg of uncondensed steam. [16]

7. Reading from a boiler trial,

(a) Height of chimney:100mm

(b) Ambient temperature:32^0C

(c) Mass of air:18 kg/kg of fuel

(d) flue gas temperature :300^0C

Find natural draught in mm of H_2O. [16]

8. The following data relate to a stage of an impulse reaction turbine: Steam velocity coming out of nozzle = 245 m/s; nozzle angle = 20^0; blade mean speed = 145 m/s; speed of the rotor = 300 r.p.m.; blade height = 10 cm; specific volume of steam at nozzle outlet and blade outlet respectively = 3.45 m^3/kg and 3.95m^3/kg; power developed by the turbine = 287 kW; efficiency of nozzle and blades combinedly = 90%; carry over co-efficient = 0.82. Find:

(a) The heat drop in each stage;

(b) Degree of reaction;

(c) Stage efficiency. [16]

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Code No: 07A60303 **R07** **Set No. 3**

III B.Tech II Semester Examinations,December 2010
THERMAL ENGINEERING - II
Mechanical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. In a surface condenser, air enters the condenser along with the steam at a rate of 10 kg/hr. The temperature of air cooler inlet section is 32^0C and the outlet is at 29^0C. The vacuum in the condenser is kept constant at 715 mm of Hg, while the barometer reads 755 mm of Hg. Calculate,
   (a) The volume of air entering the cooling section per hour.
   (b) The mass of moisture contained in the air.
   (c) The mass of steam condensed per hour in the cooling section. [16]
2. (a) Derive the condition for maximum discharge of flue gases through the chimney.
   (b) State and describe the working of Lancashire boiler. [16]
3. With the help of a neat diagram, explain the working of a Ram jet engine? What are its advantages and disadvantages compared to a Turbojet engine? [16]
4. Enumerate the energy losses in steam turbines and what are the remedies do you propose. [16]
5. In a gas turbine, the air is compressed to a pressure ratio of 6 when the air enters at 15 ^{0}C. The same air is then heated to a maximum possible temperature of 750^0C, first in a regenerator and then in a combustion chamber. It is then expanded in two stages such that the expansion work is maximum. The air is reheated to 750 ^{0}C after the first stage. Determine the cycle thermal efficiency, the work ratio and the net work per kg of air. [16]
6. What is Degree of Reaction? Show that for a Parsons Reaction turbine, the fixed and moving blades have same shape. [16]
7. Steam enters a convergent-divergent nozzle at 10 bar and 240^0C with the approach velocity of 50 m/s. it is discharged at 0.5 bar with a velocity of 978 m/s. the expansion is up to throat and with friction in the divergent part Determine:
   (a) Final quality of steam.
   (b) Diameter at exit if the throat diameter is 10 mm.
   (c) Number of nozzles required for a steam flow rate of 60 kg/min. [16]
8. (a) How are the maximum temperature and maximum pressure in the rankine cycle fixed?
   (b) When is reheating of steam recommended in s steam power plant? How does the reheat pressure get optimized? [8+8]

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