Code No: RR310303 **Set No.1**

III B.Tech. I Semester Regular Examinations, November -2005
THERMAL ENGINEERING-II
(Mechanical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) What is the effect of regeneration on efficiency and specific work output of the steam power plant? Show the cycle on T-s plot.
   (b) Explain the principle of operation of any one type of fire tube boiler with a neat sketch. [6+10]

2. A steam turbine develops 185 KW with a consumption of 16.5 Kg/KWh. Pressure and temp. of the steam at inlet of nozzle are 12 Bar and 220^0 C respectively. The steam leaves the nozzle at 1.2 Bar. The diameter of nozzle at throat is 7 mm. Find the no of nozzles. [16]

3. A surface condenser fitted with separate air and water extraction pumps, has a portion of the tubes near the air pump suction screened off from the steam so that the air is cooled below the condensate temperature. The steam enters the condenser at 38^0C and the condensate is removed at 37^0C. The air removed has a temperature of 36^0C. If the total air infiltration from all sources together is 5 kg/h. Determine the volume of air handled by the air pump per hour. What would be the corresponding value of the air handled if a combined air and condensate pump was employed? Assume uniform pressure in the condenser. [16]

4. In a De Laval turbine steam issues from the nozzle with a velocity of 1200m/s.The nozzle angle is 20^0, the mean blade velocity is 400m/s, and the inlet and outlet angles of blades are equal. The mass of steam flowing through the turbine per hour is 1000 kg. Calculate:
   (a) Blade angles.
   (b) Relative velocity of steam entering the blades.
   (c) Tangential force on the blades.
   (d) Power developed.
   (e) Blade efficiency.
   Take velocity coefficient as 0.8 [16]

5. (a) What do you mean by compounding of steam turbines? Discuss various methods of compounding steam turbines?
   (b) Explain the difference between an impulse turbine and a reaction turbine? [10+6]

6. (a) What are the factors to be considered for improving the performance of the gas Turbine and explain them briefly.

(b) Drive the expression for efficiency of a simple gas turbine cycle interns of pressure ratio. [6+10]

7. In a jet propulsion unit air is drawn into the rotary compressor at 15o C and 1 bar (Abs.) and delivered at 4 bar (Abs.). The isentropic efficiency of compression is 82% and the compression is uncooled. After delivery the air is heated at constant pressure until the temperature reaches 750^0 C. The air then passes through a turbine unit, which drives the compressor only and has an isentropic efficiency of 78% before passing through the nozzle and expanding to atmospheric pressure of 1 bar (Abs.) with an efficiency of 88%

   Neglecting any mass increase due to weight of the fuel and assuming that R andγ are unchanged by combustion, determine:

   (a) The power required to drive the compressor

   (b) Air-fuel ratio if the fuel has calorific value of 42000 KJ/kg.

   (c) The pressure of the gases leaving the turbine

   (d) The thrust per kg of air per second.
   Neglect any effect from the velocity of approach. Assume R = 0.287 KJ/ kg-K and $\gamma = 1.4$ for air. [16]

.

8. (a) What is ramjet? Explain the working of a ramjet with a neat sketch.

   (b) Explain the following terms

   i. Isentropic Compressor efficiency
   ii. Isentropic Turbine efficiency
   iii. Propelling nozzle efficiency
   iv. Transmission efficiency. [8+8]

⋆ ⋆ ⋆ ⋆ ⋆

III B.Tech. I Semester Regular Examinations, November -2005
THERMAL ENGINEERING-II
(Mechanical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Give the detailed classification of boilers?
   (b) Write short notes on any one Boiler accessory with the schematic sketch. [6+10]

2. The throat diameter of a nozzle is 5 mm. If dry and saturated steam at 10 bar is supplied to the nozzle, calculated the mass flow rate. The exhaust pressure is 1.5 bar.
   (a) Assume friction less adiabatic flow.
   (b) If 10 % of the isentropic heat drop lost in friction, what should be the correct diameter at outlet for steam to issue at the same exhaust pressure? [16]

3. The air leakage into a surface condenser operating with a steam turbine is estimated as 84 Kg/hr. The vacuum near the inlet of air pump is 700 mm of Hg. When Barometer reads 760 mm of Hg. The temp. at the inlet of vacuum pump is 20^0C.Calculate
   (a) Min. capacity of air pump in m^3/hr.
   (b) The dimensions of the reciprocating air pump to remove the air if it run at 200 RPM and L/D ratio=1.5 and volumetric efficiency =100%.
   (c) The mass of vapour extracted per minute. [16]

4. In an impulse turbine (with a single row wheel) the mean diameter of the blades is 1.05m and speed is 3000r.p.m.The nozzle angle is 18^0, the ratio of the blade speed to steam speed is 0.42 and the ratio of the relative velocity at outlet from the blades to that at inlet is 0.84.The outlet angle of the blade is to be made 3^0 less than the inlet angle. The steam flow is 10kg(S)s. Draw The velocity diagram for the blades and derive the following:
   (a) Tangential thrust on the blades
   (b) Axial thrust on the blades
   (c) Resultant thrust on the blades
   (d) Power developed in the blades
   (e) Blading efficiency. [16]

5. (a) Sketch a combined velocity diagram with reference to steam turbines. Name and mark all angles and velocities on it.

(b) In a stage of impulse reaction turbine operating with 50% degree of reaction, the blades are identical in shape. The outlet angle of the moving blades is 19^0 and the absolute discharge velocity of steam is 100m/s in the direction at $100^0$to the motion of the blades. If the rate of flow of steam through the turbine is 15000 kg/hr, calculate the power developed by the turbine in kW. [8+8]

6. (a) The following data is refers to a closed cycle gas turbine plant
Atmospheric Air temperature 27^0C
Maximum temperature of the cycle 823^0C
Pressure at compressor inlet 1 bar
Pressure ratio 4
Compressor efficiency 80%
Turbine efficiency 85%
Heating value of fuel 41,800 kJ/Kg
Turbine efficiency 80%
Heater loss 10% of Heating value

Find.

i. Work ratio
ii. Turbine work
iii. Compressor work
iv. Heat supplied Assume the working substance is Air ,regard as simple gas with Cp = 1 KJ/Kg ^{0}K and $^\gamma = 1.4$

(b) What is "regeneration " in gas turbines. [12+4]

7. (a) What do you mean by jet propulsion? Explain the Various devices in a jet propulsion unit.

(b) Prove that the propulsion of a rocket motor is obtained is
$\eta p = 2(C_a/C_{je})/(1 + (C_a/C_{je})^2)$

Where C_a=flight speed
C_{je}=effective jet velocity of rocket motor. [6+10]

8. Discuss the theory of the rocket engine. [16]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: RR310303 **Set No.3**

III B.Tech. I Semester Regular Examinations, November -2005
THERMAL ENGINEERING-II
(Mechanical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. The following readings were obtained during a boiler trial of 6 hrs duration.
   Mean steam pressure = 12 bar
   Mean of steam generated = 40000kg
   Mean dryness fraction = 0.85
   Mean feed water temperature = 30^0C
   Coal used = 4000 kg calorific value of coal = 33,400 KJ/kg
   Calculate:

   (a) Factor of equivalent evaporator
   (b) Equivalent evaporation from at 100^0C.
   (c) Efficiency of the boiler. [16]

2. A convergent divergent nozzle is required to discharge 2 kg of steam per second. The nozzle is supplied with a steam at 7 bar and 180^0C and discharge takes place against a backpressure of 1 bar. The expansion upto throat is isentropic and the frictional resistance between the throat and exit is equivalent to 63 kJ/kg of steam. Taking approach velocity of 75 m/s and throat pressure of 4 bar. Estimate :

   (a) Suitable areas for the throat and exit.
   (b) Overall efficiency of the nozzle based on the enthalpy drop between the actual inlet pressure and temperature and the exit pressure. [16]

3. (a) What are the objectives of a steam condenser in a steam power plant?
   (b) Explain the working of high level jet condenser, with the help of a neat sketch. [6+10]

4. In a Delaval turbine, the steam issues from the nozzles with a velocity of 850m/s. the nozzle angle is 20^0. Mean blade velocity is 350m/s.the blades are equiangular. The mass flow rate is 1000kg/min.friction factor is 0.8.determine:

   (a) Blade angles
   (b) Axial thrust on the end bearing
   (c) Power developed in kW
   (d) Blade efficiency
   (e) Stage efficiency, if nozzle efficiency is 93% [16]

5. (a) What do you mean by compounding of steam turbines? Discuss various methods of compounding steam turbines?
   (b) Explain the difference between an impulse turbine and a reaction turbine? [10+6]

6. A closed cycle gas turbine using Argon as the working fluid has a two compression with perfect inter cooling. The overall pressure ratio is 9 and pressure ratio in each stage is equal. Each stage has an isentropic efficiency of 85%. The turbine is also two stage with equal pressure ratio with inter change reheat to original temperature. Each turbine stage has an isentropic efficiency of 90%. The turbine inlet temperature is 1100K and the compressor inlet is 303K. Find
   (a) work done per kg of fluid flow
   (b) work ratio
   (c) The overall cycle efficiency.
   The properties of argon are Cp= 0.5207kJ/kg ^{0}K,γ =1.667 and R=0.20813kJ/kg^{0}K [16]

7. A turbo-jet engine consumes air at the rate of 60.2 kg/s when flying at a speed of 1000 km/hr. Calculate:
   (a) Exit velocity of the jet when the enthalpy for the nozzle is 230 KJ/kg. and velocity coefficient of the jet is 0.96
   (b) Fuel flow rate in kg/s when air-fuel ratio is 70:1
   (c) Thrust specific fuel consumption
   (d) Thermal efficiency of the plant when the combustion efficiency is 92% and the calorific value of the fuel is 42000 KJ/kg
   (e) Propulsive power
   (f) Propulsive efficiency
   (g) Overall efficiency. [16]

8. (a) Explain with a neat sketch a Screw Propeller Unit.
   (b) What are the fundamental differences between jet propulsion and rocket propulsion? [8+8]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: RR310303 **Set No.4**

III B.Tech. I Semester Regular Examinations, November -2005
THERMAL ENGINEERING-II
(Mechanical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) A steam turbine operating on the Rankine cycle receives steam from the boiler at 3.5 MN/m2 and 350^0C and exhaust to the condenser at 10 kN/m^2.The condensate is then returned to the boiler by the feed pump. Determine the following considering pump work also.
   i. the energy supplied in the steam generator
   ii. the dryness fraction of the steam entering the condenser,
   iii. the Rankine efficiency.
   (b) What is the difference between economizer and superheater? Why are they used in a boiler? [12+4]

2. (a) Discuss the criteria to decide the shape of the nozzles.
   (b) A gas expands in a convergent divergent nozzle from 5 bar to 1.5 bar, the initial temperature being 700^0C . Calculate the velocities at the throat and at the exit. [6+10]

3. The air leakage into surface condenser operating with a steam turbine is estimated as 84 kg/h. The vacuum near the inlet air pump is 700 mm of Hg when barometer reads 760 mm of Hg. The temperature at inlet of vacuum pump is 20^0C. Calculate: The minimum capacity of the air pump to remove the air if it runs at 200 rpm. Take L/D ratio = 1.5 and volumetric efficiency = 100% and 3. The mass of vapour extracted per minute. [16]

4. In a single row impulse turbine the nozzle angle is 30^0 and the blade speed is 215 m/sec. The steam speed is 550 m/sec. The blade friction coefficient is 0.85. assuming axial exit and a flow rate of 700 kg/hr, determine
   (a) the blade angles ,
   (b) the absolute velocity of steam at exit and
   (c) the power output of the turbine. [16]

5. (a) Show that for a Parson's reaction turbine the degree of reaction is 50%.
   (b) In a 50% reaction turbine stage running at 3000rpm, the exit angles are $30^0$and the inlet angles are 50^0. The mean diameter is 1m.The steam flow rate is 10000kg/minute and the stage efficiency is 85%.
   Determine:
   i. Power output of the stage.

ii. The specific enthalpy drop in the stage.

iii. The percentage increase in the relative velocity of the steam when it flows over the moving blades. [8+8]

6. (a) Explain with neat sketch open cycle gas turbine plant.

   (b) Enumerate the differences between open cycle gas turbine plant and closed Cycle turbine plant. [8+8]

7. A turbo prop aircraft is flying at 720km/hr at an altitude where the temperature is -18^0 C, determine the specific power output and the thermal efficiency. The specifications are: Compressor pressure ratio is 9, maximum cycle temperature is 800^o C, intake duct efficiency is 90%, isentropic efficiency of the compressor is 86%, isentropic efficiency of the turbine is 90%, Mechanical efficiency is 92%. Neglect the pressure loss in the combustion chamber and assume that the exhaust gases leave the aircraft at 720 km/hr relative to aircraft. Take C_p and γ for the compression process 1.005 KJ/kg-K and 1.4 and for combustion and expansion process 1.15 KJ/kg-K and 1.35 respectively. [16]

8. (a) What is ramjet? Explain the working of a ramjet with a neat sketch.

   (b) Explain the following terms

   i. Isentropic Compressor efficiency

   ii. Isentropic Turbine efficiency

   iii. Propelling nozzle efficiency

   iv. Transmission efficiency. [8+8]

⋆ ⋆ ⋆ ⋆ ⋆