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

III B.Tech I Semester Supplementary Examinations, March 2006
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 is the use of cooling tower in a steam power plant? Mention the different types of cooling towers.
   (b) With the neat sketch explain the operation of Benson boiler. [4+12]

2. Compare the mass of discharge from a convergent-divergent nozzle expanding from 8 Bar and 210^0C to 0.1 bar. When the
   (a) Expansion takes place under thermal equilibrium
   (b) The steam is super saturated condition during part of its expansion. [16]

3. The following observations were recorded during test on a steam condenser.
   Recorded condenser vacuum =710 mm of Hg
   Barometer reading =765 mm 0f Hg
   Mean condenser temperature =34^0 C
   Temp. of hot well =28.5^0 C
   Condensate collected =1800 Kg/hr
   Weight of cooling water =57,500 Kg/hr
   Inlet temp. of cooling water =8.5^0 C
   Outlet temp. of cooling water =26^0 C
   Calculate:
   (a) Vacuum corrected to the Std. Barometer reading
   (b) Vacuum efficiency of the condenser
   (c) Under cooling of the condenser
   (d) Condenser efficiency
   (e) Quality of steam entering the condenser.
   (f) Mass of air per Kg of uncondensed steam
   (g) Mass of air per m3 of condenser volume. [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 is the Parson's Reaction turbine?

(b) A 50% reaction turbine (with symmetrical velocity triangles) running at 400 rpm has the exit angle of the blades as 20^o and the velocity of steam relative to the blades at the exit is 1.35 times the mean blade speed. The steam flow rate is 8.33 kg/s and at a particular stage the specific volume is 1.381 m3/kg. Calculate for this stage:

i. The suitable blade height, assuming the rotor mean diameter as 12 times the blade height, and

ii. The diagram work. [6+10]

6. (a) Show that optimum pressure ratio for maximum specific output for a gas turbine plant is rp (optimum) $=\{\eta\ turbine \times \eta\, compressor \times (T3/T1)\}^{\gamma/2(\gamma-1)}$ where T3 is Maximum temperature of cycle

T1 is Minimum temperature of of cycle

(b) List out any four applications of gas turbines. [12+4]

7. (a) What are the important properties of a good propellant?

(b) In a jet propulsion cycle air enters the compressor at 1 bar, 15^0 C. The pressure leaving the compressor is 5 bar and the maximum temperature is 900^0 C. The air expands in the turbine to such a pressure that the turbine work is just equal to the compressor work. On leaving the turbine, the air expands in a reversible adiabatic process in a nozzle to 1 bar. Calculate the velocity leaving the nozzle. Take C_p=1.0035 and$\gamma = 1.4$ for compressor and expansion processes. [4+12]

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

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Code No: RR310303 **Set No. 2**

III B.Tech I Semester Supplementary Examinations, March 2006
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) With the neat sketch explain stinling boiler.
   (b) Explain various heat losses in a boiler. [10+6]

2. A convergent divergent nozzle is required to pass 1.8 kg of steam per second. At inlet the steam pressure and actual temperature are 7 bar and 200^0C respectively and the speed is 75 m/s. Expansion is stable throughout to the exit pressure of 1.1bar. There is no loss by friction in the converging section of the section, but loss by friction between throat and outlet is equivalent to 71 kJ/kg of steam. Calculate
   (a) the required area of throat in mm^2,
   (b) the required area of outlet in $mm^2$and
   (c) the overall efficiency of the nozzle, based on the heat drop between the actual inlet pressure and temperature and the outlet 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. (a) Define and derive an expression for stage efficiency incase of a steam turbine.
   (b) In an impulse turbine the nozzles are inclined at 24^0 to the plane of rotation of the blades. Steam speed is 1000 m/sec and blade speed is 400 m/sec. Assuming equiangular blades, determine
      i. blade angles,
      ii. axial thrust,
      iii. force on the blades in the direction of motion,
      iv. power developed for a flow rate of 1000 kg/hr. [8+8]

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. In gas turbine plant, operating on joules cycle, maximum and minimum temperatures of 825^0C and 27 ^{0}C . The pressure ratio is 4.5. Calculate the specific work output , cycle efficiency and work ratio. Assume isentropic efficiency of compressor and turbine 85%and 90% respectively. What is the heat rate in kJ / kW-hr. If the rating of the turbine is 1300kW, what is the mass flow in kg/s. Neglect the mass of fuel. Cp=1.005 kJ/kg ^{0}K. [16]

7. A turbo-jet engine flying at a speed of 960 km/hr consumes air at the rate of 54.5 kg/s. Calculate

   (a) Exit velocity of jet when the enthalpy change for the nozzle is 200 KJ/kg and velocity coefficient is 0.97.

   (b) Fuel flow rate in kg/s when air-fuel ratio is 75:1.

   (c) Trust specific fuel consumption.

   (d) Thermal efficiency of the plant when the combustion efficiency is 93% and calorific value of the fuel is 45000 KJ/kg.

   (e) Propulsive power.

   (f) Propulsive efficiency.
   Overall efficiency. [16]

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

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

III B.Tech I Semester Supplementary Examinations, March 2006
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) In a Rankine cycle, the steam at inlet to turbine is saturated at a pressure of 35 bar and the exhaust pressure is 0.2 bar. Determine.
   i. The pump work
   ii. The turbine work
   iii. The Rankine efficiency
   iv. The Condensor heat flow.
   Assume flow rate of 9.5 kg/s

   (b) In a chimney of height 50mts, temperature of flue gases with Natural draught is 367 60.The temperature of waste gases by using artificial draught is 127 ^{0}C. The temperature of outside air is 27 ^{0}C. If air supplied is 19 kg/kg of fuel burnt, determine the efficiency of chimney.
   Assume Cp = 1.005 KJ/kg for flue gases. [8+8]

2. (a) Calculate the throat and exit diameters of a convergent-divergent nozzle which will discharge 820 Kg of steam per hour. from a pressure of 8 Bar superheated to 220^{0}C into a chamber having a pressure of 1.5 Bar. The friction loss in divergent portion of the nozzle may be taken as 0.15 of the total enthalpy drop.

   (b) Discuss the importance of the divergent portion of the convergent - Divergent Nozzle. [10+6]

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 an impulse turbine the steam issues from the nozzle with speed of 600 m/s and blade speed is 120 m/s. the velocity is compounded by passing the steam through a ring of moving blades; through a ring of fixed blades and finally through a ring of moving blades.
   The nozzle angle is 180 ad the blade exit angles and relative velocity coefficients are:
   1^{st} row moving: 20^o & 0.8
   fixed row : 25^o & 0.85
   2^{nd} row moving: 30^o & 0.9
   find the diagram efficiency under these conditions and the power output for steam flow rate of 5 kg/sec. [16]

5. (a) Deduce an expression for work done for stage of a reaction turbine and determine the condition for maximum efficiency.

   (b) A 50% Parson's reaction turbine has a mean drum diameter of 200 cm. The speed is 600 rpm and the steam consumption is 5 kg/sec. The other data is:
   blade speed ratio = 0.45; velocity loss factor = 0.85;
   nozzle efficiency both for the stator and rotor blades = 0.9;
   exit angle of stator and rotor blades = 200.
   Neglecting carry over and wind age loss, estimate the power developed per stage, blade efficiency and stage efficiency. [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) Define the following terms:

   i. Thrust
   ii. Thrust power
   iii. Propulsive power
   iv. Propulsive efficiency

   (b) What is the basic Thermodynamic cycle used for jet propulsion and draw the T-S diagram for turbojet engine. [12+4]

8. (a) Why liquid propellants are preferred in rocket propulsion?

   (b) A simple turbojet unit operates with a turbine inlet temperature of 1100^0K, a pressure ratio is 4:1 and a mass flow of 22.7 Kg/Sec. under design conditions. The following component efficiencies may be assumed: Isentropic Compressor efficiency - 0.85
   Isentropic Turbine efficiency - 0.90
   Propelling nozzle efficiency - 0.95

Transmission efficiency - 0.99
Combustion chamber loss - 0.21 bar
Calculate the design thrust and specific fuel consumption when the unit is stationary at sea level where the ambient conditions may be taken as 1.013 bar and 288K. [6+10]

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

III B.Tech I Semester Supplementary Examinations, March 2006
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 fusible plug used as boiler mounting with the neat sketch.
   (b) Calculate the mass of flue gases flowing through the chimney when the draught produced is equal to 2 cm of water. Temperature of flue gases is 290^0C and ambient temperature is 25^0C. the flue gases formed per kg of fuel burnt are 23 kg. Neglect the losses and take the mean diameter of the chimney as 2 m. [8+8]

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. 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 the steam issues from the nozzle with speed of 600 m/s and blade speed is 120 m/s. the velocity is compounded by passing the steam through a ring of moving blades; through a ring of fixed blades and finally through a ring of moving blades.
   The nozzle angle is 180 ad the blade exit angles and relative velocity coefficients are:
   1^{st} row moving: 20^o & 0.8
   fixed row : 25^o & 0.85
   2^{nd} row moving: 30^o & 0.9
   find the diagram efficiency under these conditions and the power output for steam flow rate of 5 kg/sec. [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) Derive the expressions for the efficiency and specific work output for a simple gas turbine cycle in terms of pressure ratio.
   (b) What are the assumptions made in the analysis of ideal gas turbine cycle.
   (c) How the performance of combustion chamber in gas turbine is given? [10+3+3]

7. (a) Describe the effect of altitude on turbo jet unit.
   (b) How do the thrust and thrust power of a turbojet engine vary with flight speed? Compare these with a reciprocating engine. How thrust is augmented for the off and climb? [6+10]

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

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