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

III B.Tech. I Semester Supplementary Examinations, May -2005
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) A steam generator delivers steam at 100 bar, 500^0C. The feed water inlet temperature is 160^0C. The steam generation rate is 100,000 kg/hr and the steam generator efficiency is 88%. Determine:
   i. The fuel burning rate in kg/hr, if the calorific value of the fuel is 21 MJ/kg,
   ii. The percentage of total heat absorbed in the economizer, evaporator and superheater. Assume that only latent heat is absorbed in the evaporator and neglect any pressure drop.
   (b) What are the functions of Blow off Cock and Feed Check Valve?

2. Air expands under reversible adiabatic conditions in a nozzle from a 4 Bar and 725^0 C to a final pressure of 1 Bar. Determine:
   (a) Type of nozzle required.
   (b) Critical velocity.
   (c) Air flow rate if the min. nozzle diameter is 1.25 cm. If the nozzle requires a divergent section, determine max. velocity developed in the nozzle and the suitable exit diameter.

3. (a) What are the reasons for inefficiency in surface condenser?
   (b) A surface condenser is designed to handle 10,000 Kg of steam per hour. The steam enters at 0.08 Bar and 0.9 dryness and the condensate leaves at corresponding saturation temperature .The pressure is constant through out the condenser. Estimate the cooling water flow rate per hour, f the cooling water temp. Rise is limited to 10^0 C.

4. Steam with absolute velocity of 300m/sec, is supplied through a nozzle to a single stage impulse turbine. The nozzle angle is 25^0. The mean diameter of the blade rotor is 1metre and it has a speed of 2000r.p.m.find the suitable blade angles for zero axial thrust. If the blade velocity coefficient is 0.9 and the steam flow rate is 10kg/sec, calculate the power developed.

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?

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

7. (a) Explain the significance of effective speed ratio on Specific thrust and overall thermal efficiency in a turbojet engine.

   (b) Briefly explain the needs and demands to be met by a modern turbo-jet engine.

8. (a) Explain with a neat sketch a Screw Propeller Unit.

   (b) What are the fundamental differences between jet propulsion and rocket propulsion?

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

III B.Tech. I Semester Supplementary Examinations, May -2005
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 in detail the working of locomotive boiler with the neat sketch.
   (b) A boiler uses 18 kg air per kg of fuel. Determine the minimum height of chimney required to produce a draught of 25 mm of water. The mean temperature of chimney gases is 315^0C and that of outside air 27^0C.

2. Show that the condition for maximum discharge in a steam nozzle is $(p_2/p_1) = (2/n+1)^{(n/n-1)}$and further estimate maximum velocity and maximum discharge ?

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.

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.

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?

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

7. The following data are applicable to a jet unit in flight Speed of airplane = 950 km/hr
Stagnation pressure and temperature at turbine exit = 180 kN/m^2, 800 K
Atmospheric pressure = 60 kN/m^2
Nozzle efficiency = 98%
Air flow = 25 kg/s
Fuel-air ratio = 0.018
Lower calorific value of liquid fuel = 40000 kJ/kg
Calculate:

   (a) Gross and net thrusts

   (b) Jet equivalent velocity and

   (c) Propulsive, thermal and overall efficiencies.

8. (a) Describe a solid propellant rocket engine with a neat sketch.

   (b) What are the advantages and disadvantages of rocket engine?

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

III B.Tech. I Semester Supplementary Examinations, May -2005
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) A steam turbine is supplied with steam having an enthalpy of 3000 kJ/kg. It moves out of the turbine with an enthalpy of 2100 kJ/kg. Feed water heating is done at a pressure of 3.2 bar with steam enthalpy of 2500 kJ/kg. The condensate with an enthalpy of 125 kJ/kg enters into the feed water heater. The quantity of bled steam is 11200 kg/hr. Find the power developed by the turbine. Assume the water leaving the feed water heater is saturated at 3.2 bar and the heater is direct mixing type.
   (b) Write down the advantages of high pressure boilers.

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.

3. (a) With the help of neat sketch explain the working of a surface condenser.
   (b) Explain the need of an air pump during the working of surface condenser

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.

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?

6. In a gas turbine plant, the air at 283^0K and 1 bar is compressed to 4 bar with Isentropic compressions efficiency of 80% . The air is heated in the regenerator and in the combustion chamber till its temperature is raised to 973^0 K and during the Process pressure falls by 0.1 bar. The air is then expended in the expander isentropically and passes through the regenerator which has 0.75 effectiveness and cause a pressure drop of 0.12 bar. Determine thermal efficiency of the plant if the isentropic efficiency of expander is 0.85

7. (a) Differentiate between a jet propulsion unit and a gas turbine unit.
   (b) Define and derive an expression for the thermal efficiency of turbojet engine.

8. (a) Describe nuclear rocket engine with a neat sketch.
   (b) What are the other kinds of rocket propulsion? Mention some of them.

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III B.Tech. I Semester Supplementary Examinations, May -2005
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

2. (a) Discuss the effect of friction on flow through steam nozzles. Explain with the help of H-S Diagram
   (b) Dry saturated steam at a pressure of 10 bar with negligible velocity expands in Convergent Divergent nozzle to 1 Bar and Dryness fraction 0.94.Determine the velocity of steam leaving the nozzle.

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^{0}C and the condensate is removed at 37^{0}C. The air removed has a temperature of 36^{0}C. 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.

4. A single row impulse turbine develops 132.4 kw at a blade speed of 175m/s, using 2kg of steam per sec. steam leaves the nozzle at 400m/s. Velocity coefficient of the blades is 0.9.Steam leaves the turbine blades axially. Determine the nozzle angle, Blade angles at entry and exit, assuming no shock.

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.

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

7. (a) Define propulsive efficiency and propulsive power.

   (b) Deduce an expression for the overall efficiency of propulsive system and state the condition for the maximum value.

8. Discuss the theory of the rocket engine.

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