Code No: 09A50306 | R09 | SET-1

B. Tech III Year I Semester Examinations, December-2011
APPLIED THERMODYNAMICS - II
(MECHANICAL ENGINEERING, AUTOMOBILE ENGINEERING)

Time: 3 hours **Max. Marks: 75**

Answer any five questions
All questions carry equal marks

Use of Steam Tables is permissible

1. In a steam power plant operating on an ideal Rankine cycle, the steam enters the turbine at 3 MPa and 400^0C and is exhausted at 10 kPa. Assuming all ideal processes, determine the following:
   a) Thermal efficiency of the cycle and condition of steam at the exit of turbine
   b) Thermal efficiency if steam is supplied at 3 MPa and 500^0C and condition of steam at he exit of turbine. Estimate the increase or decrease of thermal efficiency due to super heating and comment on the result of thermal efficiency and steam exit condition from turbine comparing the two cases. [15]

2. The following readings were recorded during a 2 hour boiler trial on a boiler:

Feed water supplied	: 14000 kg
Boiler working pressure	: 10 bar
Dryness fraction of the steam	: 0.96
Temperature of feed water entering Economizer	: 35^0C
Temperature of feed water leaving Economizer	: 90^0C
Temperature of steam leaving super heater	: 250^0C
Coal burnt	: 1500 kg
Calorific value of the coal	: 33500 kJ/kg

   Conduct Boiler Trial based on the data. Also evaluate the overall efficiency of the boiler. Also evaluate the equivalent evaporation from and at 100^0C. [15]

3.a) Give the physical explanation of Critical pressure ratio of Convergent nozzle.
   b) In a convergent – divergent nozzle, the steam enters at 15 bar and 300^0C and leaves at a pressure of 2 bar. The inlet velocity to the nozzle is 150 m/s. Find the required throat and exit areas for a mass flow rate of 1 kg/s. Assume the nozzle efficiency to be 90%. [7+8]

4. Steam issues from a nozzle of a simple impulse turbine with a velocity of 610 m/s. The nozzle angle is 20^0 and the diameter of the rotor is 62 cm and runs at 9500 RPM. The blade outlet angle is 30^0 and the friction factor is 0.8. Calculate the power developed for kg of steam and diagram efficiency by drawing velocity triangles. [15]

5.a) Compare the impulse and reaction turbines.

b) Show that for a Parson's reaction turbine, the fixed and moving blades are of same shape. [7+8]

6.a) Give the comparison between jet and surface condensers.

b) A surface condenser of 0.75 m^3 capacity contains saturated steam and air at a temperature of 45^0C and an absolute pressure of 0.13 bar. Air leaks further into condenser and the hence the absolute pressure of the condenser is increased to 0.28 bar and the temperature falls to 38^0C. Calculate the mass of air leaked into the condenser. [7+8]

7. In a reheat regenerative gas turbine plant, the pressure ratio of the compressor is 4:1. The temperature of the gases entering the HP turbine and LP turbine are 660^0C and 625^0C respectively. Condition of air entering the compressor is 1 bar and 17^0C. The effectiveness of the regenerative heat exchanger is 0.75. Calculate the pressure of gases entering the LP turbine and the overall plant efficiency. [15]

8.a) Differentiate between air breathing engines and rockets.

b) With the help of a neat diagram, explain the function of a pulse jet engine along with its applications. [7+8]

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B. Tech III Year I Semester Examinations, December-2011
APPLIED THERMODYNAMICS - II
(MECHANICAL ENGINEERING, AUTOMOBILE ENGINEERING)

Time: 3 hours **Max. Marks: 75**

Answer any five questions
All questions carry equal marks

Use of Steam Tables is permissible

1. In a steam power plant operating on an ideal Rankine cycle, the steam enters the turbine at 3 MPa and 400^0C and is exhausted at 10 kPa. Assuming all ideal processes, determine the following:
   a) Thermal efficiency of the cycle and condition of steam at the exit of turbine
   b) Thermal efficiency if steam is supplied at 10 MPa and 400^0C and condition of steam at the exit of turbine. Estimate the increase or decrease of thermal efficiency due to increase of boiler pressure and comment on the result of thermal efficiency and steam exit condition from turbine comparing the two cases. [15]

2. Calculate the motor power required to drive a fan which maintains a draught of 45 mm of water under the following conditions: a) Induced draught and b) Forced draught. The temperature of the flue gases leaving the boiler in each case is 200^0C and the boiler house temperature is 33^0C. The air supplied is 18.5 kg per kg of the fuel. The mass of coal burnt per hour is 1820 kg. Assume a fan efficiency of 80% in both the cases. Comment on the result. [15]

3.a) Explain the functioning of Convergent – divergent nozzle under off design conditions, representing the variation of pressure and velocity along the length of the nozzle.

b) Steam enters the nozzle at a pressure of 2 MPa and 400^0C with a negligible approach velocity and leaves at a pressure of 3 bar. What is the shape of the nozzle? Assuming isentropic flow through nozzle, obtain the exit diameter for a mass flow rate of 2.5 kg/s. [7+8]

4. The rotor of an impulse turbine is of 260 mm diameter and runs at 20500 RPM. The nozzle angle is 20^0 and issues a steam jet with a velocity of 910 m/s. The mass flow rate is 2 kg/s. Draw the velocity triangles and evaluate a) Tangential force on blades, b) Axial force on blades c) power developed by the turbine wheel, d) Blade efficiency and e) Inlet angle of the blades. [15]

5. Derive the expression for Blade efficiency of Parson's reaction turbine and hence obtain the condition for maximum efficiency. Derive the expression for maximum efficiency. Make necessary assumptions. [15]

6. Data from the trial on a surface condenser is as follows:
   Barometer reading : 760 mm of Hg
   Condenser Vacuum : 705 mm of Hg

Condenser mean temperature	: 35^0C
Hot well temperature	: 28^0C
Temperature rise of cooling water	: 16^0C
Mass of steam condensed	: 2000 kg/h
Mass of water circulated	: 60000 kg/h
Cooling water inlet temperature	: 20^0C

Evaluate a) Corrected vacuum to standard barometer reading, b) Vacuum efficiency, c) Condenser efficiency, d) Under cooling of condensate, e) Condition of steam leaving the condenser and f) Mass of air present in the condenser per unit condenser volume. [15]

7. The air supplied to a gas turbine plant is 10 kg/s. The pressure ratio is 6 and the pressure at the inlet of the compressor is 1 bar. The compressor is two stage and is provided with a perfect inter cooling. The inlet temperature of air is 300K and the maximum temperature is limited to 1073K. A regenerator with an effectiveness of 0.7 is included in the plant. Neglecting the mass of fuel, determine the thermal efficiency of the plant. [15]

8. With the help of a neat diagram, explain the principle of solid propulsion rocket? Where is it used? What are requirements of solid propellants? [15]

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B. Tech III Year I Semester Examinations, December-2011
APPLIED THERMODYNAMICS - II
(MECHANICAL ENGINEERING, AUTOMOBILE ENGINEERING)

Time: 3 hours **Max. Marks: 75**

Answer any five questions
All questions carry equal marks

Use of Steam Tables is permissible

1. In a steam power plant operating on an ideal Rankine cycle, the steam enters the turbine at 3 MPa and 400^0C and is exhausted at 10 kPa. Assuming all ideal processes, determine the following:
   a) Thermal efficiency of the cycle and condition of steam at the exit of turbine
   b) Thermal efficiency if steam is reheated to 400^0C after the expansion from 3 MPa to 0.1 MPa and condition of steam at the exit of turbine.
   Estimate the increase or decrease of thermal efficiency for the reheat cycle compared to simple cycle and comment on the result of thermal efficiency and steam exit condition from turbine comparing the two cases. [15]

2.a) Enlist the relative advantages and disadvantages of Induced and Forced draught fans in the boiler.

b) How much air is used per kg of fuel burnt in a boiler having a chimney of height, 35 m to create a draught of 20 mm of water. The temperature of flue gases in the chimney is 370^0C and the boiler house temperature is 34^0C. What would be the temperature of flue gases if the discharge through the chimney to be maximum? Comment on the result. [7+8]

3. A steam turbine develops 190 kW with a steam consumption of 18 kg/kWh. The pressure and temperature of steam entering the nozzle are 12 bar and 250^0C respectively. The steam leaves the nozzles at 1 bar. The diameter of the nozzle at the throat is 8 mm. Find the number of nozzles used.
   If 10% of the enthalpy drop is lost due to friction in the diverging portion of the nozzle, determine the exit diameter. [15]

4. In a stage of Parson's reaction turbine, the mean diameter of the wheel is 1.05 m and the speed is 3000 RPM. The angles of receiving tips are 35^0 and the discharging tips is 20^0. If the steam flow rate is 1kg/min, draw the velocity diagram for blades and evaluate a) Tangential thrust on blades, b) Axial thrust on blades, c) Power developed in the blades and d) Diagram efficiency. [15]

5. What is meant by compounding of Impulse turbine? Explain each case of compounding by representing the variation of pressure and velocity of working fluid along the turbine. [15]

6. Data from the trial on a surface condenser is as follows:
   Barometer reading : 764 mm of Hg

Condenser Vacuum	: 680 mm of Hg
Condenser mean temperature	: 36.2^0C
Hot well temperature	: 30^0C
Temperature rise of cooling water	: 12^0C
Mass of steam condensed	: 1780 kg/h
Mass of water circulated	: 1250 kg/min
Cooling water inlet temperature	: 20^0C

Evaluate a) Corrected vacuum to standard barometer reading, b) Vacuum efficiency, c) Condenser efficiency, d) Under cooling of condensate and e) Condition of steam leaving the condenser. [15]

7. A gas turbine has a pressure ratio of 6 and a maximum cycle temperature of 600^0C. The isentropic efficiency of the compressor and turbine are 82% and 85% respectively. Calculate the power input in kW to the electric generator geared to the turbine with a transmission efficiency of 95%. The air enters the compressor at 15^0C at a rate of 15 kg/s. Take C_p of gases = 1.11 kJ/kg-K and γ = 1.333 for the expansion process. [15]

8.a) What are different types of liquid propellants used and their desirable properties?
b) Briefly explain different methods to augment the thrust in propulsion engines. [7+8]

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B. Tech III Year I Semester Examinations, December-2011
APPLIED THERMODYNAMICS - II
(MECHANICAL ENGINEERING, AUTOMOBILE ENGINEERING)

Time: 3 hours **Max. Marks: 75**

Answer any five questions
All questions carry equal marks

Use of Steam Tables is permissible

1. In a steam power plant operating on an ideal Rankine cycle, the steam enters the turbine at 3 MPa and 400^0C and is exhausted at 10 kPa. Assuming all ideal processes, determine the following:
   a) Thermal efficiency of the cycle and heat supplied in the boiler
   b) Thermal efficiency if steam is bled from the turbine at a pressure of 0.1 MPa and is used to heat the feed water in an open feed water heater.
   Estimate the increase or decrease of thermal efficiency for the regenerative cycle compared to simple cycle and comment on the result of thermal efficiency and heat supplied in the boiler for both cases. [15]

2.a) What is meant by Boiler Trial? Explain by means of a Boiler Trial table. Why it needs to be performed?
b) A boiler is equipped with a chimney of 30 m height. The ambient temperature is 25^0C. The temperature of flue gases passing through the chimney is 300^0C. If the air flow is 20 kg per kg of fuel burnt. Find the draught produced and the velocity of flue gases through the chimney when 50% of the theoretical draught is lost in friction. [7+8]

3.a) Explain the phenomenon of supersaturated flow in nozzles. Why and how it happens?
b) The steam is supplied at 15 bar, 350^0C and exits at 1 bar. If the divergent portion of the nozzle is 80 mm long and the throat diameter is 6 mm, determine the cone angle of the divergent portion. Assume 12% of total enthalpy drop is lost in the friction in the divergent portion. [7+8]

4. The nozzles of a de-Laval turbine deliver 1.5 kg/s of steam at a speed of 800 m/s to a ring of moving blades having a speed of 200 m/s. The exit angle of the nozzle is 18^0. If the blade velocity coefficient is 0.75 and the exit angle of the moving blades is 25^0, calculate a) Inlet angle of the moving and fixed blades, b) Diagram efficiency, c) Energy lost in blades per second, d) Power developed and e) Axial thrust on the turbine rotor. [15]

5.a) Give the comparison of Impulse and Reaction turbines.
b) Show that for a Parson's reaction turbine, the fixed and moving blades are of same shape. Make necessary assumptions. [7+8]

6.a) What are the elements of a Condensing plant? Briefly explain the function of each element or component.

b) With the help of a neat diagram, explain the function of Barometric condenser. [7+8]

7. In a gas turbine plant of 6MW capacity, air enters the compressor at 100 kPa, 300K and is compressed to a pressure of 600 kPa in one stage. The temperature at the inlet of high pressure turbine is 1000K. The expansion takes place in two stages with an intermediate reheat to 1000K. A regenerator having an effectiveness of 0.72 is incorporated to heat the compressed air before entering into combustion chamber. The calorific value of the fuel is 18500 kJ/kg, determine the following:

a) A/F ratio of gases entering the first turbine
b) Thermal efficiency of the cycle
c) Air supply to the plant
d) Fuel consumption of the plant per hour

Take C_p of gases = 1.15 kJ/kg-K and γ = 1.34 [15]

8.a) What are different performance parameters used for Propulsion engines? Briefly explain by means of formula.

b) Differentiate between jet and rocket engines. [7+8]

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