Code No: 07A52403 **R07** **Set No. 2**

III B.Tech I Semester Examinations,May 2011
THERMAL ENGINEERING - II
Automobile Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. In a reaction turbine, the blade tips are inclined at 35^0 and 20^0 in the direction of motion. The guide blades, but reversed in direction. At a certain place in the turbine, the drum diameter is 1 metre and the blades are 10 cm high. At this place, the steam has a pressure of 1.75 bar and dryness 0.935. If the speed of this turbine is 250 rpm and the steam passes through the blades without shock, find the mass of steam flow and power developed in the ring of moving blades. [16]

2. (a) Draw the graph 'blade-speed ratio' versus 'diagram efficiency' of a reaction turbine.
   (b) Describe the constructional features and working principle of a de Laval turbine. Also draw the 'pressure' and 'velocity' graphs of this turbine. [4+12]

3. A turbo jet engine inducts 51 kg of air per second and propels an aircraft with an uniform flight speed of 912 km/h. The isentropic enthalpy change for the nozzle is 200 kj/kg and its velocity co efficiency is 0.96. The fuel air ratio is 0.0119, the combustion efficiency is 096 and the lower heating value of the fuel is 42mj/kg. Calculate
   (a) The thermal efficiency of the engine,
   (b) The fuel flow rate in kg/h and tsfc,
   (c) The propulsive power in kw
   (d) The thrust power and
   (e) The propulsive efficiency. [16]

4. (a) What are the advantages of unleaded petrol and premium petrol? (3+3)
   (b) The analysis of flue gas by the Orsat's apparatus showed: carbon dioxide = 13.2%, carbon monoxide = 1.8%, oxygen = 3.2%, and nitrogen = 81.8%. Assuming that the fuel contains only the carbon and hydrogen atoms, calculate.
      i. The ratio of carbon to hydrogen atoms,
      ii. The molar composition of the wet flue gases? [6+10]

5. A surface condenser deals with 13625 kg of steam per hour at a pressure of 0.09 bar. The steam enters 0.85 dry and the temperature at the condensate and air extraction pipes is 36^0C. The air leakage amounts to 7.26 kg/hour. Determine:
   (a) The surface required if the average heat transmission rate is 3.97 kJ/cm^2 per second.

(b) The cylinder diameter for the dry air pump, if it is to be single acting at 60 r.p.m. with a stroke to bore ratio of 1.25 and volumetric efficiency of 0.85.[16]

6. (a) Explain the phenomenon overexpansion and underexpansion in a covnvergent divergent Nozzle.

   (b) Steam enters a nozzle operating at steady state with a pressure of 40 bar, a temperature of 400^0C, and a velocity of 10 m/s. The steam flows through the nozzle with negligible heat transfer, and no significant change in potential energy. At the exit, the pressure is 15 bar and the velocity is 665 m/s. The mass flow rate is 2 kg/s. Determine the exit area of the nozzle in m^2. [8+8]

7. A 4500 kW gas turbine generating set operates with two compressor stages; the overall pressure ratio is 9:1. A high pressure turbine is used to drive the compressors, and a low- pressure turbine the generator. Temperature of the gases at entry to the high pressure turbine is 625^0C and the gases are reheated to 625^0C after expansion in the first turbine. The exhaust gases leaving the low-pressure turbine are passed through a heat exchanger to heat air leaving the high pressure stage compressor. The compressors have equal pressure ratios and inter cooling is complete between the stages. The air inlet temperature to the unit is 20^0C. The isentropic efficiency of each compressor stage is 0.8, and the isentropic efficiency of each turbine stage is 0.85, the heat exchanger thermal ratio is 0.8. A mechanical efficiency of 95% can be assumed for the both the power shaft and compressor turbine shaft. Neglecting all pressure losses and changes in kinetic energy calculate:

   (a) The thermal efficiency

   (b) Work ratio of the plant.

   (c) The mass flow in kg/s. Neglect the mass of the fuel and assume the following:
   For air: C_{pa} = 1.005 kJ/kg K and $\gamma = 1.4$.
   For gases in the combustion chamber and in turbines and heat exchanger, C_{pg} = 1.15 kJ/kg K and $\gamma = 1.333$. [16]

8. (a) With a neat sketch, describe the principle of working of an induced draught.

   (b) Derive the expression for maximum flow of hot gas through a chimney of height 'H' and cross sectional area 'A'. [8+8]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: 07A52403 **R07** **Set No. 4**

III B.Tech I Semester Examinations,May 2011
THERMAL ENGINEERING - II
Automobile Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Define degree of supersaturation and degree of under cooling with regards to supersaturated through nozzles.
   (b) Derive the expression for exit velocity of a convergent nozzle, from steady state to steady flow energy equation. [7+9]

2. (a) What are the sources of air leakages in the condensers?
   (b) Explain the effects of air leakage in a condenser and also method to prevail vaccum inside? [8+8]

3. (a) What do you mean by pure reaction turbine? Describe the working principle with the help of a simple sketch.
   (b) A simple impulse turbine has one ring of moving blades running at 150 m/s. The absolute velocity of the steam at exit from the blades is 90 m/s, at an angle of 80^0 from the tangential direction. The blade velocity coefficient is 0.83 and the flow of steam through the stage is 3 kg/s. If the blades are equiangular, determine:
      i. The blade angles.
      ii. Nozzle angle, and
      iii. Axial thrust. [6+10]

4. Briefly explain the chemical structure of petroleum. [16]

5. (a) Discuss the outstanding features of a locomotive boiler.
   (b) What are the advantages of Benson boiler? [8+8]

6. At the stage in the reaction turbine the pressure of steam is 0.34bar and the dryness 0.95. for a flow rate of 36000kg/hr the stage develops 950kW.the turbine runs at 3600r.p.m. and the velocity of the flow is 0.72 times the blade velocity the outlet angle of both stator and rotor blades is 20^0. Determine at this stage:
   (a) Mean rotor diameter.
   (b) Height of blades. [16]

7. The following data pertain to a turbo-jet flying at an altitude of 9500 m: Speed of the turbo-jet = 800 km/h
   Propulsive efficiency = 55%
   Overall efficiency of the turbine plant = 17%

Density of air at 9500m altitude = 0.17 kg/m^3
Drag on the plane = 6100 N
Assuming calorific value of the fuels used as = 46000 kJ/kg,
Calculate:

(a) Absolute velocity of the jet
(b) Volume of air compressed per minute.
(c) Diameter of the Jet.
(d) Power output of the unit.
(e) Air-fuel ratio. [16]

8. Air is taken in a gas turbine plant at 1.1 bar 20^0C. The plant comprises of L.P. and H.P. compressors and L.P. and H.P. turbines. The compression in L.P. Stage is up to 3.3 bar followed by inter cooling to 27^0C. The pressure of air after H.P. compressor is 9.45 bar. Loss of pressure during inter cooling is 0.15 bar. Air from H.P. compressor is transferred to heat exchanger of effectiveness 0.65 where it is heated by the gases from L.P. turbine. After heat exchanger the air passes through combustion chamber. The temperature of gases supplied to H.P. turbine is 700^0C. The gases expand in H.P. turbine to 3.62 bar and air then reheated to 670^0C before expanding in L.P. turbine. The loss of pressure in reheater is 0.12 bar. Determine;

(a) The overall efficiency
(b) The work ratio
(c) The mass flow rate when the power generated is 6000 kW. Assume: Isentropic efficiency of compression in both stages = 0.82.
Isentropic efficiency of expansion in turbine = 0.85.
For air : C_p = 1.005 kJ/kg K and γ = 1.4.
For gases : C_p = 1.15 kJ/kg K and γ = 1.333.
Neglect the mass of the fuel. [16]

⋆⋆⋆⋆⋆

Code No: 07A52403 **R07** **Set No. 1**

III B.Tech I Semester Examinations,May 2011
THERMAL ENGINEERING - II
Automobile Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. A turbo jet engine is being used to propel an aeroplane. The drag is 3900 N. The co efficient of drag is 0.01835. The wing area is 21.25 m^2. The air consumption per second of the engine is 14.5 kg/s and the thrust developed is 8900 N. Calculate the velocity and effective jet velocity. Also calculate the specific thrust where the c_p =1.005 kj/kg k. What is the density ratio at this altitude of 10000 m. Take $\rho =$ 0.5 kg/m^3 at this altitude. [16]

2. (a) What do you mean by supersaturated flow in steam nozzle(s)? Explain with the help of Mollier's chart.
   (b) Dry saturated steam at 3.5 bar having negligible velocity expands in a convergent nozzle to 1.3 bar and dryness fraction 0.94. Calculate velocity of steam leaving nozzle. [6+10]

3. (a) What are the functions of fixed and moving blades of an impulse-reaction turbine?
   (b) In a simple impulse turbine, the nozzles are inclined at 22^0 to the direction of motion of the moving blades. The steam leaves the nozzle at 400 m/s. The blade speed is 165 m/s. Find the suitable inlet and outlet angles for the moving blades in order that the axial thrust is zero. The relative velocity of steam as it flows over the moving blades is reduced by 15 per cent by friction. Determine also the power developed for a steam flow rate of 8 kg/s. [6+10]

4. A twenty stage parson turbine receives steam at 15 bar at 300^0C. The steam leaves the turbine at 0.1 bar pressure. The turbine has the stage efficiency of 80% and the factor 1.06.the total power developed by the turbine is 10665kW. Find the steam flow rate through the turbine assuming all stages develop equal power. The pressure of steam, at certain stage of the turbine is 1 bar abs., and is dry and saturated. The blade exit angle is 25% and the blade speed ratio is 0.75. find the mean diameter of the rotor of this stage and also the rotor speed. Take blade height as $1/12^{th}$ of the mean diameter. The thickness of the blades is neglected. [16]

5. (a) What are the advantages of Velox boiler?
   (b) Draw the layout of a boiler. What are the considerations in locating super heater, economizer and air pre-heater? [8+8]

6. In a gas turbine plant, of power output 2100 KW, a rotary compressor of isentropic efficiency 0.83 is used to compress 30 kg/s air(cp = 1.0 kj/kg k, k = 1.4), at compression ratio 5.0 and total head inlet temperature 295 k, inlet pressure 95

kN/m^2. the air after compression passes through a heat exchanger, in which its temperature is raised to 625 k. the flow rate of fuel of calorific value 45000kj/kg, is 0.25 kg/s. in the turbine, gases(c_p = 1.15 kj/kg k, k = 1.3)expand from 460 to 99 kN/m^2, leave at 682 k. calculate isentropic efficiency of the turbine. Find combustion efficiency, the thermal ratio of the heat exchanger. Find also the gain in over all efficiency by fitting the heat exchanger. [16]

7. In a surface condenser test the following observations were made: vacuum 70 cm of Hg :barometer 76.5 cm of Hg : mean temperature of the condensate 35.82^{0}C; hot well temperature 30^{0}C; weight of cooling water 47500 kg/h; inlet temperature of cooling water Calculate:

   (a) The mass of air present per m^3 of condenser volume;

   (b) The state of steam entering the condenser, and

   (c) The vacuum efficiency. [16]

8. (a) How coal is formed? Rank the coal on the basis of carbon and moisture content? And also mention their calorific values.

   (b) Ethane (C_2H_6) is burnt in air at stoichiometric proportion. Calculate the air-fuel ratio. [9+7]

⋆⋆⋆⋆⋆

Code No: 07A52403 **R07** **Set No. 3**

III B.Tech I Semester Examinations,May 2011
THERMAL ENGINEERING - II
Automobile Engineering

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

Answer any FIVE Questions
All Questions carry equal marks
⋆ ⋆ ⋆ ⋆ ⋆

1. (a) State the heating values of fossil fuels:
   i. Natural gas,
   ii. Liquid petrol,
   iii. High speed diesel,
   iv. Kerosene,
   v. Liquefied petroleum gas,
   vi. Ethane,
   vii. Methane, and
   viii. Anthracite.

   (b) Find the A/F ratio for hexane on man and volume basis when combustion is with stoichiometric and 20% excess air. [8+8]

2. Extend the above example on the turbofan. With the additional information that the combustion efficiency is 0.99, determine the s.c .also calculate the thrust and s.c when a combustion chamber is incorporated inn the by-pass duct and the 'cold' stream is heated to 1000k.the combustion efficiency and pressure and loss for this process may be assumed to be 0.97 and 0.05 bar respectively .assume cv=42mj/kg . [16]

3. (a) What do you mean by the term 'full admission' of a reaction turbine?

   (b) Describe the constructional features and working principle of a Curtis turbine. Also draw the 'pressure' and 'velocity' profiles for a two stages Curtis turbine. [4+12]

4. (a) Why the length of divergent position is larger than the convergent position? Explain.

   (b) Steam at 20 bar, 300^0C enters a convergent-divergent nozzle at the rate of 0.3 kg/s with negligible inlet velocity and expands into a space at 3 bar. Assuming that the steam expands isentropically according to a law $pv^{1.3}$ = constant, estimate the throat and exit areas of the nozzles without using h-s (mollier) chart. [6+10]

5. The following data relate to a stage of reaction turbine
   Mean rotor diameter = 1.5 m; speed ratio = 0.72; blade outlet angle = 20^0; rotor speed = 3000 r.p.m.

   (a) Determine the diagram efficiency.

(b) Determine the percentage increase in diagram efficiency and the rotor speed if the rotor is designed to run at the best theoretical speed, the exit angle being 20^0 [16]

6. (a) Differentiate between central flow and downward flow surface condensor.

   (b) In a condenser air pump and water pump are separately installed. Steam enters the condenser at 41.5^0C and the condensate is removed at 37.6^0C.the quantity of air infiltrating into the condenser through various zones is 6 kg/h. determine:

      i. The volume of air handled by the air pump.

      ii. The quantity handled by a combined air and condensate pump at 39^0C. Make suitable assumptions and list all such assumptions. [8+8]

7. In a closed cycle gas turbine there is two-stage compressor and a two stage turbine. All the components are mounted on the same shaft. The pressure and temperature at the inlet of the first-stage compressor are 1.5 bar and 20^0C. The maximum cycle temperature and pressure are limited to 750^0C and 6 bar. The perfect intercooler is used between the two stage compressors and a reheater is used between the two turbines. Gases are heated in the reheater to 750^0C before entering in to the L.P.turbine. Assuming the compressor and turbine efficiencies as 0.82, calculate:

   (a) The efficiency of the cycle without regenerator.

   (b) The efficiency of the cycle with a regenerator whose effectiveness is 0.70.

   (c) The mass of the fuel circulated if the power developed by the plant is 350 kW The working fluid used in the cycle is air. For air: C_p = 1.005 kJ/kg K and γ = 1.4. [16]

8. Explain why safety valves are needed in a boiler. Draw a neat sketch of spring loaded safety valve and explain its working. [8+8]

⋆⋆⋆⋆⋆