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

III B.Tech I Semester Regular Examinations, November 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) A turbine is supplied with steam at a pressure of 32 bar and a temperature of 410^0C. The steam then expands isentropically to a pressuere of 0.08 bar. Find the dryness fraction at the end of expansion and thermal efficiency of the cycle. If the steam is reheated at 5.5 bar to a temperature of 395^0C and then expanded isentropically to a pressure of 0.08 bar, what will be the dryness fraction and thermal efficiency of the cycle?
   (b) What are the factors to be considered while selecting a boiler? [10+6]

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. 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. [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 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) 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. (a) Describe a solid propellant rocket engine with a neat sketch.
   (b) What are the advantages and disadvantages of rocket engine? [10+6]

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

III B.Tech I Semester Regular Examinations, November 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 turbine is supplied with steam at a pressure of 32 bar and a temp. of 410^0C. The steam then expands isentropically to a pressure of 0.08 bar. Find the dryness fraction at the and of expansion and thermal efficiency of the cycle. If the steam is reheated at 5.5 bar to a temp. of 400^0C and then expanded isentropically to a pressure of 0.08 bar, what will be the dryness fraction and thermal efficiency of the cycle. [16]

2. A convergent-divergent nozzle for a steam turbine has to deliver 400 Kg of steam per hour under a supply condition of 10 Bar dry and saturated ,and a back pressure of 0.1 Bar Initial velocity of steam is 150 m/s. Neglect friction.Find throat and outlet areas. [16]

3. In a condenser test following observations are made.
   Vacuum=700 mm of Hg, Barometer Reading=760 mm of Hg,
   Mean temp of condensation=350C, Hot well temp=28^0C
   Mass of cooling water=50,000 Kg/hr
   Inlet temp=17^0C, Outlet temp=30^0C
   Mass of condensate per hour=1250Kg
   Find :
   (a) Mass of air present per m3 of condenser volume.
   (b) The state of steam entering the condenser.
   (c) Vacuum efficiency. [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) 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-jet has a speed of 750 km/hr, while flying at an altitude of 10000m. The propulsive efficiency of the jet is 50% and the overall efficiency of the turbine plant is 16%. The density of air at 10000m altitude is 0.173 kg/m^3. The drag of the plant is 6250 N. The calorific value of the fuel is 48,000 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 in KW.
(e) Air-fuel ratio. [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]

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

III B.Tech I Semester Regular Examinations, November 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) 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 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. (a) What are the main functions of air pump? Discuss the working of Edward air pump with a neat diagram ?
   (b) Discuss the differences between down flow and central flow condensers ? [10+6]

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. (a) How the gas turbine cycles classified?

   (b) A Gas turbine plant works between the temperature limits of 1152^0K and 288^0 K Isentropic efficiency for compressor and turbines are 0.85 and 0.8 respectively. Determine the optimum pressure ratio for maximum work output and also for maximum Cycle thermal efficiency. [6+10]

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) Where is rocket propulsion is used? What are the kinds of rocket propellants?

   (b) Describe a liquid propellant rocket engine with a neat sketch. [12+4]

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

III B.Tech I Semester Regular Examinations, November 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) Give the detailed classification of boilers?
   (b) Write short notes on any one Boiler accessory with the schematic 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. 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 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) 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) 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 jet propulsion unit consists of compressor, combustion chamber, turbine and nozzle. The air at 0.65 bar and 272K is compressed in the compressor to 3 bar. η_c =0.85.The temperature of the gases at inlet to the turbine is 700^0 C , and the η_t =0.80. The gases coming out of the turbine are expanded in a nozzle to a pressure 0.564 bar. The η of the nozzle is 0.90. Neglecting the pressure and mechanical losses and fuel mass, find the following:

(a) A:F ratio used assuming C.V. of fuel 44000 KJ/ Kg and the η_{com}.=0.90.

(b) Power required to run the compressor

(c) Pressure of the gases entering the nozzle

(d) The thrust developed per kg of air per sec.
Take C_p=1.005 KJ/Kg-K, γ = 1.4 for air and C_p=1.005 KJ/Kg-K, γ = 1.4 for air and C_p=1.1514 KJ/Kg-K, γ = 1.33 for gases.
Speed of the jet propulsion unit is 720 Km/h. [16]

8. (a) Explain with a neat sketch a Turbo-Prop System.

(b) Explain with a sketch a rocket propulsion unit. [8+8]

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