**III B.Tech. I Semester Regular Examinations, November -2005**
**TURBO MACHINERY**
**(Production Engineering)**

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

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

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1. (a) Explain the effect of area change in subsonic and supersonic flow at inlet and outlet of a duct?
   (b) Explain the pressure distribution and flow through a convergent-divergent nozzle with a neat sketch? [6+10]

2. (a) What is boundary layer separation? How it affect when a fluid flows over a an aerofoil?
   (b) An aero plane wing area of 10 $m^2$ is flying in a straight and level flight at a speed of 40 m/s, if the lift and drag co-efficient are 0.7 and 0.2 respectively, find the lift force and drag force. [8+8]

3. (a) With a neat sketch explain the working principle of a centrifugal compressor.
   (b) What are the design requirements of a centrifugal compressor, explain in brief. [8+8]

4. (a) What are the different steps involved in the gas turbine combustion process?
   (b) A simple gas turbine plant operates on constant pressure cycle with a pressure ratio of 4:1 aspires air from atmosphere at $18^0$C and 1.02bar. If the cycle maximum temperature is $810^0$C, turbine isentropic efficiency is 92%, plant overall efficiency is 25%. Find the isentropic efficiency of compressor and work ratio. Take $C_p = 1.005$ kJ/kg.K and $\gamma = 1.4$. [6+10]

5. The steam from nozzles of a single wheel impulse turbine discharges with a velocity of 600m/s and at $20^0$to the plane of wheel. The blade wheel rotates at 3000RPM and the mean blade radius is 590mm. The axial velocity of steam at exit from the blades is 164m/s and the blades are symmetrical. Calculate
   (a) the blade angles,
   (b) the diagram work per unit mass flow rate of steam,
   (c) the diagram efficiency, and
   (d) the blade velocity co-efficient. [16]

6. The following data refers to a 50% reaction turbine;drum diameter : 2m, speed of rotation : 800RPM, and steam flow rate is 15kg/s. The height blade is 15cm and the steam has a pressure of 0.4bar and 0.95 dryness fraction. For $20^0$ discharge angle and assuming turbine efficiency as 80%. Estimate the power developed in this particular ring and enthalpy drop when the steam passes through the turbine pair. [16]

7. (a) What are Athodyds? Explain working of Ramjet with a neat sketch?
   (b) What are the advantages and disadvantages of turbojet compared to a propeller? [8+8]

8. Write the short notes:-
   (a) Stage and Overall efficiency
   (b) Advantages of solid propellant
   (c) Power input factor
   (d) Throttle governing [4+4+4+4]

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Code No: RR312003 **Set No.2**

**III B.Tech. I Semester Regular Examinations, November -2005**
**TURBO MACHINERY**
**(Production Engineering)**

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

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

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1. (a) Explain with neat sketch the development of boundary layer on a smooth plate held parallel to uniform flow?
   (b) Define and explain the terms boundary layer and boundary layer theory?

   [10+6]

2. Air at 1.02bar and $30^0$C enters an axial flow compressor stage with an axial velocity of 180m/s. The rotor stage has a tip diameter of 0.55m and 0.5m and rotates at a speed of 6500RPM. The air enters the rotor and leaves the stator in the axial direction with no change in velocity or radius. The air is turned through $30^0$ as it passes through rotor. Assuming constant specific heats and that the air enters and leaves the blade at the blade angles. Determine
   (a) mass flow rate,
   (b) power requires,
   (c) degree of reaction. [16]

3. The following data pertaining to a centrifugal compressor:

| | |
|---|---|
| overall diameter of the impeller | - 60cm |
| speed | - 14000RPM |
| slip factor | - 0.9 |
| power input factor | - 1.04 |
| eye tip diameter | - 35cm |
| eye root diameter | - 20cm |
| total mass flow | - 20kg/s |
| inlet total head temperature and pressure | - $25^0$C and 1.01bar |
| total head isentropic efficiency | - 82% |

   Determine the total head pressure ratio and power required to drive the compressor, if the velocity of air at inlet is axial. [16]

4. (a) What are the advantages of constant volume gas turbine cycle compared to constant pressure gas turbine cycle?
   (b) The following particulars relate to a gas turbine plant with inter cooler and reheater. Determine net work output, efficiency and work ratio.

| | |
|---|---|
| ambient temperature | - $15^0$C |
| ambient pressure | - 1.01bar |
| pressure ratio of each compressor | - 2:1 |
| pressure ratio of each turbine | - 2:1 |

maximum cycle temperature - $800^0$ C
mass flow rate of air - 18kg/s
Assume ideal conditions in intercooler and reheater. [6+10]

5. (a) What are the different types of nozzles? Explain each with a neat sketch.
   (b) A convergent-divergent nozzle is required to discharge 2kg/s of steam at 7bar and $180^0$C and discharge takes place against a backpressure of 1bar. Expansion is assumed to be isentropic and approach velocity is 75m/s. Estimate the suitable area for the throat and exit. [6+10]

6. Derive the condition for maximum blade efficiency in a reaction turbine from the fundamentals. What are the assumptions made while deriving the above condition?

[16]

7. The data pertaining to a stationary jet propulsion unit is as follows: Ambient conditions $15^0$C and 1bar, pressure ratio 4.5:1, maximum cycle temperature 1000K, compressor and turbine isentropic efficiencies are 75% and 80% respectively, combustion efficiency is 0.95, and mechanical transmission efficiency is 0.98. For a mass flow of 25kg/s calculate the specific thrust and thrust power. For air take $C_p$ = 1.005 kJ/kg.K and $\gamma = 1.4$, for gases $C_p = 1.33$ kJ/kg.K and $\gamma = 1.33$. [16]

8. Write the short notes:-
   (a) Lift and Drag
   (b) Types of propellants
   (c) Chocked flow in Centrifugal Compressors
   (d) Co-generation [4+4+4+4]

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Code No: RR312003 **Set No.3**

**III B.Tech. I Semester Regular Examinations, November -2005**
**TURBO MACHINERY**
**(Production Engineering)**

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

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

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1. (a) What is a Boundary layer? Explain how Boundary layer affects the flow phenomenon.
   (b) What do you understand by the terms laminar boundary layer, turbulent boundary layer, laminar sub-layer and boundary layer thickness. [8+8]

2. (a) What is an aerofoil section? Explain the nomenclature of an aerofoil with neat sketch?
   (b) How the pressure distribution takes place around an aerofoil with the increase in incident angle? Explain with neat sketches. [6+10]

3. The data of a centrifugal compressor are given below:

| | |
|---|---|
| outer diameter of the impeller | - 50cm |
| tip diameter of the eye | - 28cm |
| hub diameter of the eye | - 14cm |
| speed | - 16,000RPM |
| mass of air handled | - 10 kg/s |
| total value of temperature at inlet | - $20^0$C |
| total value of pressure at inlet | - 1.15bar |
| slip factor | - 0.91 |
| total efficiency | - 75% |

   For zero whirl at entry, determine the total pressure ratio developed and power required to drive the compressor. [16]

4. (a) What are the different combustion chamber arrangements?
   (b) Derive the expression for specific work out put, efficiency and work ratio for a simple cycle with a heat exchanger? [6+10]

5. (a) What are the different types of nozzles? Explain each with a neat sketch.
   (b) A convergent-divergent nozzle is required to discharge 2kg/s of steam at 7bar and $180^0$C and discharge takes place against a backpressure of 1bar. Expansion is assumed to be isentropic and approach velocity is 75m/s. Estimate the suitable area for the throat and exit. [6+10]

6. At a particular stage of a reaction turbine the mean blade speed is 60m/s and the steam pressure is 3.5bar with a temperature of $175^0$C. The identical fixed and moving blades have inlet angles of $30^0$ and outlet angles of $20^0$. Determine
   (a) the blade height if it is $1/10^{th}$ of the blade ring diameter for flow rate of 13.5kg/s,

(b) the power developed by air, and

(c) specific enthalpy drop if the stage efficiency is 85%. [16]

7. (a) What are Athodyds? Explain working of Ramjet with a neat sketch?

(b) What are the advantages and disadvantages of turbojet compared to a propeller? [8+8]

8. Write the short notes:-

(a) isentropic flow

(b) Uses of rockets

(c) Pressure losses in Gas Turbines

(d) Cogeneration [4+4+4+4]

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Code No: RR312003 **Set No.4**

**III B.Tech. I Semester Regular Examinations, November -2005**
**TURBO MACHINERY**
**(Production Engineering)**

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

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

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1. Describe, with the help of simple sketches the working principle of impulse and reaction turbines? [16]

2. (a) Draw the inlet and outlet velocity triangles of an axial flow compressor?
   (b) An axial flow compressor of 50% reaction desig has blades with inlet and outlet angles of $40^0$ and $10^0$. The compressor is to produce a pressure ratio of 5:1 with an overall isentropic efficiency of 87%. The mean blade speed and axial velocity are constant through out the compressor. Assuming blade velocity of 180 m/s and work input factor 0.85, find the number of stages required.

   [6+10]

3. The following data pertaining to a centrifugal compressor:

| | |
|---|---|
| overall diameter of the impeller | - 60cm |
| speed | - 14000RPM |
| slip factor | - 0.9 |
| power input factor | - 1.04 |
| eye tip diameter | - 35cm |
| eye root diameter | - 20cm |
| total mass flow | - 20kg/s |
| inlet total head temperature and pressure | - $25^0$C and 1.01bar |
| total head isentropic efficiency | - 82% |

   Determine the total head pressure ratio and power required to drive the compressor, if the velocity of air at inlet is axial. [16]

4. (a) What are the different flame stabilization methods used in gas turbine combustion chamber?
   (b) A gas turbine plant operates between temperature limits of $18^0$C and $780^0$C. The air is taken from ambient at a pressure f 1.02bar compressed to 7bar in the compressor. The heat addition takes place in a heat exchanger and combustion chamber. The hot gases are expanded in two stages such that the expansion work is maximum. The air is re heated to $780^0$C after the first stage. Determine work output, efficiency, work ratio if the mass flow rate of air is 19kg/s. Take $C_p = 1.005$ kJ/kg.K and $\gamma = 1.4$. [6+10]

5. The velocity of steam at inlet to a simple impulse turbine is 1000m/s, and the nozzle angle is $18^0$. The blade speed is 400m/s and the blades are symmetrical. Determine the blade angles if the steam is to enter the blades without shock. If the friction effects on the blade are negligible, calculate the tangential force on the

blades and the diagram power for a mass flow of 0.75kg/s. What is the axial thrust and the diagram efficiency? [16]

6. The following data refers to a 50% reaction turbine;drum diameter : 2m, speed of rotation : 800RPM, and steam flow rate is 15kg/s. The height blade is 15cm and the steam has a pressure of 0.4bar and 0.95 dryness fraction. For $20^0$ discharge angle and assuming turbine efficiency as 80%. Estimate the power developed in this particular ring and enthalpy drop when the steam passes through the turbine pair. [16]

7. A Turbo-jet engine inducts 51kg/s and propels an aircraft with an uniform flight speed of 912kg/h. The isentropic enthalpy charge for the nozzle is 200kJ/kg and its velocity co-efficient is 0.96. The fuel-air ratio is 0.0119, th ecombustion efficiency is 0.96 and the lower heating value of the fuel is 10,500KJ/kg. Assume CV = 42 MJ/kg. Calculate

   (a) the thermal efficiency of the engine,

   (b) the fuel flow rate in kg/hr and total specific fuel consumption,

   (c) the propulsion power in kW,

   (d) the thrust power, and

   (e) the propulsive efficiency. [16]

8. Write the short notes:-

   (a) Stalling

   (b) Incompressible flow

   (c) Slip and Slip factor

   (d) Combustion chamber types [4+4+4+4]

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