

VTU B.E/B.TECH QUESTION PAPER SET

CBCS SEMESTER IV

AIRCRAFT PROPULSION

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15AE43

Fourth Semester B.E. Degree Examination, June/July 2017
Aircraft Propulsion

Time: 3 hrs.

Max. Marks: 80

Note: Answer any FIVE full questions, choosing one full question from each module.

Module-1

- 1 a. Define and explain, mach number, Raynold's number. Compressible flow and incompressible flow. (06 Marks)
 b. Explain with neat diagrams the working principle of four stroke CI engine. (10 Marks)

OR

- 2 a. What is meant by Boundary layer? Explain Boundary layer separation with figure. (08 Marks)
 b. Explain with principle of aircraft propulsion with example. (08 Marks)

Module-2

- 3 a. Describe the types of propellers used for aircraft. And explain what is propeller thrust and momentum thrust with equations. (04 Marks)
 b. Explain with neat sketches the performance characteristics of Turbojet, Turboprop and Turbofan engines. (12 Marks)

OR

- 4 a. What is thrust? Derive an equation of thrust for a propulsive device and explain the factors affecting thrust. (10 Marks)
 b. Define with relevant equations i) thrust power ii) propulsive efficiency. (06 Marks)

Module-3

- 5 a. Bring out the different types of inlets used for gas turbines engines and explain with neat diagram Bell mouth shape inlet. (04 Marks)
 b. Explain the theory of isentropic flow through a convergent nozzle. (06 Marks)
 c. Air flowing in a duct has a velocity of 300m/s pressure 1.0 bar and temperature 290K. Taking $\gamma = 1.4$ and $R = 287 \text{ J/kg-K}$. Determine :
 i) Stagnation pressure and temperature
 ii) Velocity of sound in the dynamic and stagnation condition
 iii) Stagnation pressure assuming constant density. (06 Marks)

OR

- 6 a. What are over expanded and under expanded nozzle? Explain. (02 Marks)
 b. What do you mean by thrust Reversal? Explain the types of thrust reversals with figures. (06 Marks)
 c. A supersonic wind tunnel settling chamber expands air or Freon - 21 through a nozzle from a pressure of 10 bar to 4 bar in the test section. Calculate the stagnation temperature to be maintained in the settling chamber to obtain a velocity of 500 m/s in the test section for
 i) Air, $C_p = 1.025 \text{ kJ/kg K}$, $C_v = 0.735 \text{ kJ/kg K}$
 ii) F_{721} , $C_p = 0.785 \text{ kJ/kg K}$, $C_v = 0.67 \text{ kJ/kg K}$.
 What is the test section mach number in each case? (08 Marks)

Module-4

- 7 a. Explain the principle of operation of centrifugal compressors. (08 Marks)
b. A centrifugal compressor has to deliver 35kg of air per sec. the impeller is 76cm diameter revolving at 11,500 rpm with an adiabatic efficiency of 80%. If the pressure ratio is 4.2:1 estimate the probable axial width of the impeller at the impeller tip if the radial velocity is 120 m/s. The inlet conditions are 1 bar and 47°C. (08 Marks)

OR

- 8 a. Explain the performance characteristics of axial flow compressor. (06 Marks)
b. An axial flow air compressor of 50% reaction design has blades with inlet and outlet angles of 45° and 10° respectively. The compressor is to produce a pressure ratio of 6:1 with an overall isentropic efficiency of 0.85 when inlet static temperature is out the compressor. Assuming a value of 200 m/s for blade speed find the number of stages required if the work done factor is i) unity ii) 0.87 for all stages. (10 Marks)

Module-5

- 9 a. Describe the process of combustion in a gas turbine and explain classification of combustion chamber with neat diagrams. (10 Marks)
b. Explain the effect of operating variables on Burns performance. (06 Marks)

OR

- 10 a. With neat diagram explain :
i) Single stages Turbines
ii) Multistage Turbines. (06 Marks)
b. Gas at 7 bar and 300°C expands to 3 bar in an impulse turbine stage. The nozzle angle is 70° with reference to the exit direction. The rotor blades have equal inlet and outlet angle, and the stage operates with optimum blade speed ratio. Assuming that the isentropic efficiency of the nozzles is 0.9 and that the velocity at entry to the stage is negligible, deduce the blade angle used and the mass flow required for this stage to produce 75kW.
Take $C_p = 1.15 \text{ kJ/kg K}$. (10 Marks)

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15AE43

Fourth Semester B.E. Degree Examination, Dec.2017/Jan.2018
Aircraft Propulsion

Time: 3 hrs.

Max. Marks: 80

Note: Answer FIVE full questions, choosing one full question from each module.

Module-1

- 1 a. Explain types of aircraft power plant with neat sketch. (10 Marks)
 b. Write difference between four stroke engine and two stroke engine. (06 Marks)

OR

- 2 a. Write advantage of gas turbine engine over reciprocating engine. (08 Marks)
 b. Define the following:
 (i) Diffuser efficiency (ii) Compressor efficiency (iii) Combustion efficiency
 (iv) Turbine efficiency (08 Marks)

Module-2

- 3 a. Write short notes on:
 (i) Variable pitch propeller.
 (ii) Constant speed propeller. (06 Marks)
 b. Explain momentum theory of propeller. (10 Marks)

OR

- 4 a. Explain performance of turbojet engine with neat sketch. (06 Marks)
 b. Air enters a turbojet engine at a rate of 120000 kg/hr at 15°C and 1.03 bar and is compressed adiabatically to 182°C and four times the pressure. Products of combustion enter the turbine at 815°C and leave it at 650°C to enter the nozzle. Calculate the isentropic efficiency of the compressor, power required to drive the compressor, and exit speed of gases when flying at 800 km/hr. Assume the isentropic efficiency of turbine is same as that of compressor and the nozzle efficiency is 90%. (10 Marks)

Module-3

- 5 a. Derive a relation for minimum area ratio $\left(\frac{A_{max}}{A_1}\right)$ in term of external deceleration and co-efficient of pressure. (12 Marks)
 b. Write characteristics of supersonic inlet. (04 Marks)

OR

- 6 a. Write short notes on:
 (i) Nozzle choking.
 (ii) Nozzle throat condition. (08 Marks)
 b. Explain types of thrust reverser. (08 Marks)

Module-4

- 7 a. List and explain performance characteristics of centrifugal compressor. (10 Marks)
b. Explain rotating stall with sketch. (06 Marks)

OR

- 8 a. Define and derive expression for degree of reaction of axial flow compressor. (10 Marks)
b. Difference between axial flow compressor and centrifugal compressor. (06 Marks)

Module-5

- 9 a. Write advantage and disadvantage of annular combustor. (06 Marks)
b. Explain about flame tube cooling. (06 Marks)
c. Define combustion intensity. (04 Marks)

OR

- 10 a. Explain turbine blade cooling with sketch. (12 Marks)
b. Define: (i) Loading coefficient (ii) Flow coefficient. (04 Marks)

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15AE43

Fourth Semester B.E. Degree Examination, June/July 2018 Aircraft Propulsion

Time: 3 hrs.

Max. Marks: 80

**Note: Answer any FIVE full questions, choosing
ONE full question from each module.**

Module-1

- 1 a. Briefly explain the principles of aircraft propulsion. Name different types of aircraft power plants. (06 Marks)
- b. With the help of a neat schematic and P-V and T-S diagram, explain the working principle of a four stroke diesel engine. (10 Marks)

OR

- 2 a. Derive an expression for specific work output and thermal efficiency in terms of pressure ratio and temperature ratio for a simple gas turbine cycle with the help of a schematic diagram, P-V and T-S diagrams. (08 Marks)
- b. What are the advantages of gas turbine engines over reciprocating engines? (04 Marks)
- c. Define the following :
 - i) Stagnation velocity of sound
 - ii) Stagnation pressure. (04 Marks)

Module-2

- 3 a. Define a propeller and explain the different types of propellers. (06 Marks)
- b. List the three theories used in the design of propellers. Explain blade element theory in brief. (06 Marks)
- c. The effective jet exit velocity from a jet engine is 2700 m/s. The forward flight velocity is 1350 m/s and the air flow rate is 78.6 kg/s. Calculate:
 - i) thrust ii) thrust power and iii) propulsive efficiency. (04 Marks)

OR

- 4 a. With the help of a neat sketch explain the working principle of an after burner. (06 Marks)
- b. Explain the working principle of a 'TURBOJET' engine with the help of a neat schematic, P-V and T-S diagram. What are its advantages and disadvantages? (10 Marks)

Module-3

- 5 a. Explain the function and operation of a diffuser with relevant sketches. (06 Marks)
- b. With the help of a neat sketch explain the method of shock swallowing using variable area inlet. (05 Marks)
- c. Air ($\gamma = 1.4$, $R = 287.43 \text{ J/kg}^\circ\text{K}$) enters a straight axisymmetric duct at 300K, 3.45 bar, and 150 m/s and leaves it at 277K, 2.058 bar and 260m/s. The area of cross section at entry is 500 cm². Assuming adiabatic flow, determine : i) Stagnation temperature ii) maximum velocity iii) mass flow rate iv) area of cross section at exit. (05 Marks)

1 of 2

Important Note : 1. On completing your answers, do not forget to sign and date. 2. If you find any error in the questions, please report it to the invigilator immediately. 3. If you find any error in the questions, please report it to the invigilator immediately. 4. If you find any error in the questions, please report it to the invigilator immediately. 5. If you find any error in the questions, please report it to the invigilator immediately.

OR

- 6 a. Write short notes on :
- Thrust reversing and thrust vectoring
 - Engine back pressure control. (08 Marks)
- b. With the help of a neat sketch explain over – expanded and under-expanded nozzles. (08 Marks)

Module-4

- 7 a. Describe the essential parts of a centrifuged compress, with the help of a neat sketch. Explain the principle of operation. (08 Marks)
- b. A centrifuged compressor under test gave the following data :
Speed = 11,500 rev/min, Inlet total head temperature = 21°C, outlet and inlet total head pressure = 4 bar, and 1 bar, impeller dia = 75cm. If the slip factor is 0.92, what is the compressor efficiency? (08 Marks)

OR

- 8 a. Explain the process of surging and stalling in an axial flow compressor. (06 Marks)
- b. Define and derive an expression for degree of reaction of an axial flow compressor. (06 Marks)
- c. Determine the stage efficiency η_s and work done factor Ω of an axial flow compressor, if the actual pressure retro developed is 1.35 and actual temperature rise is 30K. The blade inlet and outlet angles are 47° and 15° respectively. The peripheral and axial velocities are 225 m/s and 180 m/s respectively. (04 Marks)

Module-5

- 9 a. Explain different types of combustion chambers used in gas turbine engines. Briefly discuss their advantages and disadvantages. (08 Marks)
- b. Write short notes on :
- Flame tube cooling
 - Combustion chamber geometry. (08 Marks)

OR

- 10 a. With the help of a neat sketch, explain the working of a single stage reaction turbine. (05 Marks)
- b. Explain the different methods of cooling turbine blades with relevant sketch. (05 Marks)
- c. A multistage gas turbine is to be designed with impulse stages and is to operate with an inlet pressure and temperature of 6 bar and 900K and an outlet pressure bar of 1 bar. The isentropic efficiency of the turbine is 85%. All the stages are to have a nozzle outlet angle of 75° and equal outlet and inlet blade angles. Mean baled speed of 250 m/s and equal inlet and outlet gas velocities. Estimate the maximum number of stages. Take $\gamma = 1.33$, $C_p = 1.15 \text{ kJ/kgK}$ and optimum blade speed ratio. (06 Marks)

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15AE43

Fourth Semester B.E. Degree Examination, Dec.2018/Jan.2019

Aircraft Propulsion

Time: 3 hrs.

Max. Marks: 80

Note: Answer any FIVE full questions, choosing one full question from each module.

Module-1

- 1 a. Derive an expression for steady flow energy equation for compressible flow machines with usual notations. (08 Marks)
 b. Define Stagnation state and Stagnation enthalpy. Derive an expression for stagnation temperature. (08 Marks)

OR

- 2 a. With the help of PV and TS diagram, explain the cycle analysis of Jet engine. (10 Marks)
 b. Explain the advantages of gas turbine over reciprocating engine. (06 Marks)

Module-2

- 3 a. Explain the operating principle of a turbofan engine with a neat diagram. What are the advantages and disadvantages? (10 Marks)
 b. A turbojet power plant uses aviation kerosene having a calorific value of 43MJ/kg. The fuel consumption is 0.18 kg per hour per N of thrust [0.18 kg/hr. N], when the thrust is 9kN. The aircraft velocity is 500 m/s the mass of air passing through the compressor is 27kg/s. Calculate the air – fuel ratio and overall efficiency. (06 Marks)

OR

- 4 a. Briefly explain different types of propeller. (08 Marks)
 b. The diameter of the propeller of an aircraft is 2.5m. It flies at a speed of 500 kmph at an altitude of 8000m. For a flight to jet speed ratio of 0.75, Determine
 i) the flow rate of air through the propeller ii) the thrust produced iii) specific thrust
 iv) specific impulse v) the thrust power.
 Take at $Z = 8000\text{m}$, air density $\rho = 0.525 \text{ kg/m}^3$. (08 Marks)

Module-3

- 5 a. Explain with a neat sketch, the operation of subsonic inlet under various flow speed condition. (08 Marks)
 b. Explain the concept of shock swallowing by area variation in supersonic inlets. (08 Marks)

OR

- 6 a. With the help of neat diagram, explain the different modes of inlet operations. (08 Marks)
 b. The pressure, temperature and mach number at the entry of a flow passage are 2.45 bar, 26.5°C and 1.4 respectively. If the exit mach number is 2.5, determine for adiabatic flow of a perfect gas ($\gamma = 1.3$, $R = 0.469 \text{ kJ/kg K}$).
 i) Stagnation temperature ii) Temperature and velocity of gas at exit. (08 Marks)

Module-4

- 7 a. With the help of a neat sketch, explain the principle of operation of a centrifugal compressor. (08 Marks)

- b. A centrifugal compressor under test gave the following data :
Speed = 11,500 rev/min , Inlet total head temperature = 21°C , Outlet and inlet total head pressure = 4 bar and 1 bar impeller dia = 75cm.
If the slip factor is 0.92, what is the compressor efficiency? (08 Marks)

OR

- 8 a. Define Degree of reaction of an axial flow compressor and obtain an expression for 50% degree of reaction. (08 Marks)
b. Give the advantages and disadvantages of centrifugal and axial flow compressor. (04 Marks)
c. Derive an expression for compressor efficiency in centrifugal compressor. (04 Marks)

Module-5

- 9 a. What are the classifications of combustion chamber? Explain with neat sketches. (08 Marks)
b. Explain any two of the following : (08 Marks)
i) Flame tube cooling ii) Use of cheaper fuels iii) Pollution.

OR

- 10 a. Explain the working of a single reaction stage, with a neat sketch. (08 Marks)
b. What are the factors to be considered in the selection of materials? (08 Marks)

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17AE43

Fourth Semester B.E. Degree Examination, June/July 2019
Aircraft Propulsion

Time: 3 hrs.

Max. Marks: 100

**Note: Answer any FIVE full questions, choosing
 ONE full question from each module.**

Module-1

- 1 a. Draw a neat labeled schematic diagram and explain the working principle of 4-stroke diesel engine. (10 Marks)
 b. Illustrate the advantages of gas turbine engines over reciprocating engines. (10 Marks)

OR

- 2 a. Briefly explain working principle of turbofan engine with a neat schematic diagram. Mention its merits and demerits. (12 Marks)
 b. Differentiate two-stroke and four-stroke engine. (08 Marks)

Module-2

- 3 a. Elucidate momentum theory of propellers by considering suitable assumptions. (10 Marks)
 b. What is the importance of thrust augmentation? Discuss various factors affecting thrust. (10 Marks)

OR

- 4 a. Describe the performance characteristics of turboprop and turbojet engines with suitable graphs. (12 Marks)
 b. What is a propeller? List out the various types of propeller. (03 Marks)
 c. The effective jet velocity from a jet engine is 13,320 km/hr. The forward flight velocity is 8460 km/hr and the airflow rate is 86.5 kg/sec. Calculate i) Thrust ii) Thrust power iii) Propulsive efficiency. (05 Marks)

Module-3

- 5 a. Derive a relation for minimum area ratio (A_{max}/A_1) min in terms of external deceleration (V_i/V_a). (10 Marks)
 b. List the major design considerations for the inlets. (05 Marks)
 c. Differentiate subsonic and supersonic inlets. (05 Marks)

OR

- 6 a. Discuss the various types of thrust reversal system with suitable sketch. (10 Marks)
 b. Derive an expression for diffuser efficiency. (05 Marks)
 c. Explain Ejector nozzle with a sketch. (05 Marks)

Module-4

- 7 a. With a neat sketch explain working principle of centrifugal compressor. (10 Marks)
 b. An axial flow air compressor of 50% reaction design has blades with inlet and outlet angles of 45° and 10° respectively. The compressor is to produce a pressure ratio of 6 : 1 with an overall isentropic efficiency of 0.85 when inlet static temperature is 37°C. The blade speed and axial velocity are constant through compressor. Assuming a value of 200 m/s for blade speed find the number of stages required if the work done factor is :
 i) unity and ii) 0.87 for all stages. (10 Marks)

1 of 2

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
 2. Any revealing of identification, appeal to evaluator and/or equations written eg, 42+8 = 50, will be treated as malpractice.

OR

- 8 a. Explain performance characteristics of axial compressor with a graph. (10 Marks)
b. Differentiate Axial flow compressor and centrifugal compressor. (05 Marks)
c. A centrifugal compressor has to deliver 35kg of air per second. The impeller is 76cm diameter revolving at 11500rpm with an adiabatic efficiency of 80%. If the pressure ratio is 4.2 : 1, estimate the probable axial width of the impeller tip if the radial velocity is 120m/s. The inlet conditions are /bar and 47°C. (05 Marks)

Module-5

- 9 a. With the help of a neat sketch, explain the working a radial turbine. (10 Marks)
b. Discuss the various important factors affecting combustor chamber design. (10 Marks)

OR

- 10 a. Elucidate the various methods used in turbine blade cooling. (08 Marks)
b. Describe various losses in turbines. (08 Marks)
c. Write a not eon impact of pollutants in combustion chambers. (04 Marks)

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17AE43

Fourth Semester B.E. Degree Examination, Dec.2019/Jan.2020

Aircraft Propulsion

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. Explain the principles of aircraft propulsion. List down the various types of engines. (10 Marks)
- b. Draw a schematic diagram of a simple gas turbine engine and derive the expression for air standard efficiency with P-V and T-S diagram gas turbine cycle analysis. (10 Marks)

OR

- 2 a. Briefly explain the working principles of internal combustion engine. Write difference between four stroke engine and two stroke engine. (10 Marks)
- b. With the help of a neat schematic and P-V and T-S diagram, explain the working principle of a four stroke diesel engine. (10 Marks)

Module-2

- 3 a. List the three theories used in the design of propellers. Explain momentum theory of propeller. (10 Marks)
- b. Define thrust and derive an expression for thrust equation $F = \dot{m}_i [(1+t)C_j - C_i]$. (10 Marks)

OR

- 4 a. With the help of a neat sketch explain the working principle of an after burner. What are its advantages and disadvantages? (10 Marks)
- b. Briefly explain the factors affecting thrust. The effective jet exit velocity from jet engine is 2700m/s. The forward flight velocity is 1350m/s and the airflow rate is 78.6kg/s. Calculate:
i) Thrust ii) Thrust power iii) Propulsive efficiency. (10 Marks)

Module-3

- 5 a. Explain external flow and derive a relation for minimum area ratio in terms of external deceleration ratio with usual notations. (10 Marks)
- b. With the help of a neat sketch, explain the process of shock swallowing in a variable geometry supersonic inlet. (10 Marks)

OR

- 6 a. Write short notes on :
i) Thrust reverser and thrust vectoring
ii) Nozzle choking. (10 Marks)
- b. With the help of a neat sketch, explain over-expanded and under-expanded nozzles. (10 Marks)

1 of 2

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-4

- 7 a. With the help of a schematic diagram, explain the principle of operation of a centrifugal compressor. (10 Marks)
b. Explain the process of surging and stalling in an axial flow compressor. (10 Marks)

OR

- 8 a. Define and derive expression for degree of reaction of axial flow compressor. (10 Marks)
b. Difference between axial flow compressor and centrifugal compressor. (10 Marks)

Module-5

- 9 a. Explain different types of combustion chamber used in gas turbine engines. Briefly discuss their advantages and disadvantages. (10 Marks)
b. Explain about flame tube cooling and combustion chamber geometry. (10 Marks)

OR

- 10 a. Explain the different methods of cooling turbine blades with relevant sketch. (10 Marks)
b. Explain the working of a single reaction stage with a neat sketch. (10 Marks)

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17AE43

Fourth Semester B.E. Degree Examination, Aug./Sept.2020
Aircraft Propulsion

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. With the help of PV and TS diagram, explain the cycle analysis of Jet engine. (12 Marks)
 b. Derive an expression for steady flow energy equation for compressible flow machines with usual notation. (08 Marks)

OR

- 2 a. With the help of a neat schematic and PV and TS diagram, explain the working principle of a four stroke diesel engine. (10 Marks)
 b. What are the advantages of gas turbine engines over reciprocating engine? (06 Marks)
 c. Define the following :
 (i) Stagnation velocity of sound (ii) Stagnation pressure (04 Marks)

Module-2

- 3 a. Explain the working principle of a turbojet engine with the help of a neat schematic, PV and T-S diagram. What are its advantages and disadvantages? (12 Marks)
 b. A turbojet power plant uses aviation kerosene having a calorific value of 43 MJ/kg. The fuel consumption is 0.18 kg-N/hr, when the thrust is 9 kN. The aircraft velocity is 500 m/s the mass of air passing through the compressor is 27 kg/s. Calculate the air-fuel ratio and overall efficiency. (08 Marks)

OR

- 4 a. With the help of a neat sketch explain the working principle of an after burner. (06 Marks)
 b. Define a propeller and explain the different types of propellers. (06 Marks)
 c. The diameter of the propeller of an aircraft is 2.5m. It flies at a speed of 500 kmph at an altitude of 8000m. For a flight to get speed ratio of 0.75, determine
 (i) the flow rate of air through the propeller
 (ii) the thrust produced.
 (iii) specific thrust
 (iv) specific impulse
 (v) the thrust power.
 Take at $Z = 8000\text{m}$, air density $\rho = 0.525 \text{ kg/m}^3$ (08 Marks)

Module-3

- 5 a. With the help of a neat sketch explain the method of shock swallowing using variable area inlet. (08 Marks)
 b. Explain with a neat sketch the operation of subsonic inlet under various flow speed conditions. (06 Marks)
 c. Air ($\gamma = 1.4$, $R = 287.43 \text{ J/kg } ^\circ\text{K}$) enters a straight axisymmetric duct at 300 K, 3.45 bar and 150 m/s and leaves it at 277 K, 2.058 bar and 260 m/s. The area of cross section at entry is 500 cm^2 . Assuming adiabatic flow, determine (i) Stagnation temperature (ii) Maximum velocity (iii) Mass flow rate (iv) area of cross section at exit. (06 Marks)

1 of 2

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
 2. Any revealing of identification, appeal to evaluator and /or equations written eg. 42+8 = 50, will be treated as malpractice.

OR

- 6 a. With the help of a neat sketch explain
(i) Over expanded nozzle (ii) Under expanded nozzle. (12 Marks)
b. With the help of neat diagram, explain the different modes of inlet operations. (08 Marks)

Module-4

- 7 a. Describe the essential parts of a centrifugal compressor, with the help of a neat sketch. Explain the principle of operation. (10 Marks)
b. A centrifugal compressor under test gave the following data:
Speed = 11,500 rev/min, Inlet total head temperature = 21°C outlet and inlet total head pressure = 4 bar and 1 bar. Impeller diameter = 75 cm. If the slip factor is 0.92, what is the compressor efficiency? (10 Marks)

OR

- 8 a. Define and derive an expression for degree of reaction of an axial flow compressor. (10 Marks)
b. Explain the process of surging and stalling in an axial flow compressor. (06 Marks)
c. Derive an expression for compressor efficiency in centrifugal compressor. (04 Marks)

Module-5

- 9 a. Explain different types of combustion chambers used in gas turbine engine. Briefly discuss their advantages and disadvantages. (10 Marks)
b. Explain the following :
(i) Flame tube cooling
(ii) Use of Cheaper fuels
(iii) Pollution (10 Marks)

OR

- 10 a. With the help of a neat sketch, explain the working of a single stage reaction turbine. (06 Marks)
b. Explain the different methods of cooling turbine blades with relevant sketch. (06 Marks)
c. A multistage gas turbine is to be designed with impulse stages and is to operate with an inlet pressure and temperature of 6 bar and 900 K and an outlet pressure of 1 bar. The isentropic efficiency of the turbine is 85%. All the stages are to have a nozzle outlet angle of 75° and equal outlet and inlet blade angles. Mean blade speed of 250 m/s and equal inlet and outlet gas velocities. Estimate the maximum number of stages. Take $\gamma = 1.33$, $C_p = 1.15$ kJ/kg °K and optimum blade speed ratio. (08 Marks)
