

PROPULSION-II
TWO MARKS QUESTIONS
AIRCRAFT GAS TURBINES

1. Define stage efficiency.

The stage efficiency is defined as the ratio of work done in a stage to enthalpy drop in stage.

2. Define reaction ratio.

Reaction ratio is defined as the ratio of static enthalpy drop across the rotor to static enthalpy drop across the stage.

3. What is the difference between impulse and reaction turbines?

- In impulse turbine, the fluid expanded completely in the nozzle and it remains at constant pressure during its passage through the moving blades. In reaction turbine, the fluid is only partially expanded in the nozzle and the remaining expansions take place in the rotor blades.
- The fluid velocity and blade speed for the reaction turbine are low as compared with those of an impulse turbine.

4. What are the requirements should be satisfied when the gas turbine is to be used as an aircraft power plant?

- Low weight
- Small frontal area.

5. Define work ratio.

It is the ratio of the actual total head temperature drop to the isentropic total head temperature drop from the total heat inlet to static head outlet.

6. Define total to static efficiency.

It is defined as the ratio between the actual shaft work to the ideal shaft work between the total conditions at the entry and static conditions at exit

7. What are the functions of the gas turbine?

- Turbine is the part of the jet engine which is used to increase the kinetic energy of gases.
- It is used to operate the compressor.

8. What are the primary parts of the turbines?

- The stator nozzles
- The turbine rotor blades

9. What are the classifications of the turbines?

- An impulse stage
- A reaction stage

10. What is meant by impulse turbine stage?

An impulse turbine stage is characterized by the expansion of the gases which occurs only in the stator nozzles. The rotor blades act as directional vanes to deflect the direction of the flow. Further they convert the kinetic energy of the gas into work changing the momentum of the gas more or less at constant pressure.

11. What is meant by reaction turbine?

A reaction turbine is one in which the expansion of gas takes place both in the stator and in the rotor.

12. Define blade loading coefficient.

The blade loading coefficient is defined as the ratio of work done to square of blade velocity.

13. Define degree of reaction.

It is defined as the ratio of isentropic change of enthalpy in the rotor to isentropic change in enthalpy in the stage.

14. Define optimum speed ratio.

The optimum speed ratio is the ratio of velocity of the blade to velocity of gas.

15. Write short notes on external cooling for turbine blades.

The external surface of the gas turbine blade is cooled by making use of compressed air from the compressor. The quantity of the air required for the purpose is from 1 to 3% of main flow entering the turbine stage by which blade metal temperature can be reduced by about 200 – 300 degrees.

16. Explain internal cooling method adopted for gas turbine blades?

Internal cooling of blades is achieved by passing air or liquid through internal cooling passages from hub towards the blade tip. The internal passages may be circular or elliptical. The cooling of the blades is achieved by conduction and convection.

17. What are the disadvantages of liquid cooling?

- This system is complex.
- Water is circulated at high pressure above its vapour pressure.
- It is impossible to eliminate formation of deposits.

18. Write short notes on air cooling adopted in turbine blades.

In this method, the air is bled from the high pressure end of the compressor and delivered to the blades and vanes to be cooled. Quantity of the coolant required to about 1 to 3 % of engine air flow per turbine blade row.

19. What are the assumptions made while eliminating the flow through the stage?

- Flow conditions evaluated at the mean radius.
- Blade height / mean radius is small, allowing two dimensional flow theory to be used.
- 3. Radial velocities are zero.

20. Define blade efficiency.

It is defined as the ratio of work done per unit mass flow to work available per unit mass flow.

21. Define total to total efficiency.

Total to total efficiency is the ratio of actual work done by the gas to isentropic work done.

RAMJET PROPULSION

1. Briefly explain scramjet engine?

A scramjet is a variant of a ramjet air breathing jet engine in which combustion takes place in supersonic airflow.

2. Define thrust.

Thrust is a force which propels the engine in to the forward direction. Unit for thrust is Newton.

3. Define specific impulse.

It is defined as the ratio of thrust to weight flow rate of air-fuel mixture. Unit for the specific impulse is seconds.

4. What is the function of nozzle?

The function of the nozzle is to convert the pressure energy of the fluid into kinetic energy.

5. What is Mach number?

Mach number is defined as the ratio of velocity of fluid to velocity of sound.

6. What are the burners used in the ramjet engine?

- Can type burner
- Baffle type burner

7. What is meant by ram effect?

The function of the diffuser is to convert the kinetic energy of the entering air into pressure energy. This energy transformation is called ram effect.

8. What are the assumptions made for calculate the ideal efficiency of the ramjet engine?

- Steady flow
- One dimensional flow
- Isentropic compression and expansion
- Gas is perfect
- Heat added at constant pressure
- Very low Mach number in the combustion chamber.

9. Why ramjet engine does not require a compressor and a turbine?

In ramjet engine, due to subsonic and supersonic diffuser, the static pressure of the air is increased to ignition pressure. So there is no need of compressor and turbine.

10. Define propulsive efficiency of ramjet engine.

The propulsive efficiency of ramjet engine is defined as the ratio of thrust power to power output.

11. Define combustion efficiency.

The combustion efficiency is defined as the ratio of enthalpy rise of air to heat supplied to it.

12. Define diffuser efficiency.

Diffuser efficiency is defined as the ratio of actual pressure rise to ideal pressure rise.

13. What are the advantages of ramjet engine?

- Ramjet engine is very simple and does not have any moving part.
- Cost is low.

- Less maintenance.
- There is no upper limit for flight speed.
- Light weight when compared to turbojet engine.

14. What are the disadvantages of ramjet engine?

- Since the takeoff thrust is zero, it is not possible to start a ramjet engine without an external launching device.
- The combustor required flame holder to stabilize the combustion due to high speed of air.
- It has low thermal efficiency.
- It is very difficult to design a diffuser which will give good pressure recovery over a wide range of speeds.

15. What are the applications of ramjet engine?

- It is widely used in high speed aircrafts and missiles due to its high thrust and high operational speed.
- Subsonic ramjets are used in target weapons.

16. Explain critical inlet mode operation.

When the inlet can accept the mass flow of air required positioning the terminal shock just inside the cowl lip. This is called critical inlet operation.

17. What is subcritical operation?

When the inlet is not matched to the engine, the normal shock moves upstream. This is called as subcritical operation.

18. What is super critical operation?

When the inlet cannot capture the mass flow required by the engine, the terminal shock is sucked into the diffuser. This is called super critical operation.

19. What are the factors to be considered to select the fuel for ramjet engine?

- The calorific value of fuel
- The ease with which it can be ignited
- Its physical properties
- Its storage ability
- Toxicity
- Corrosiveness

20. What are the factors affecting the combustion process?

- The burner geometry
- Physical and chemical characteristics of fuel
- The air fuel ratio
- The velocity of working fluid

FUNDAMENTALS OF ROCKET PROPULSION

1. Define IWR?

The ratio of total impulse of the rocket to total weight of the rocket is called as impulse weight ratio.

2. Explain the performance of the rocket engine.

In rocket engine, if the speed is increased, the propulsive efficiency is increased and reaches the maximum value of one. Then propulsive efficiency is decreased with increase in speed ratio.

3. What is thrust coefficient?

It is the ratio of the thrust to the throat force.

4. Define specific propellant consumption.

The propellant consumption rate per thrust is called as specific propellant consumption.

5. Define altitude.

The height of the rocket engine from the sea level is called as altitude.

6. What is the advantage of bell nozzle over conical nozzle?

The bell nozzle has 20 % less than the length that would be required for a conical nozzle.

7. What is internal ballistics?

The rocket motor's operation and design depend on the combustion characteristics of propellant, its burning rate, burning surface, and grain geometry. The branch of science describing these is known as internal ballistics.

8. Define characteristic velocity.

It is the ratio of jet velocity to thrust coefficient.

9. Define overall efficiency.

Overall efficiency is defined as the ratio of thrust power to heat supplied by the propellant.

10. Define thermal efficiency.

Thermal efficiency is the ratio of power developed by the engine to heat supplied by the propellant.

11. Define effective jet velocity.

The effective jet velocity is the ratio of thrust to mass flow rate of propellant.

12. Write short notes on aero spike nozzle.

The aero spike nozzle has common plug at its centre. The small combustion chambers arranged in a circle around a common plug. The gasses coming out from the chambers flow through the divergent section of the nozzle where they are expanded.

13. State the comparison between jet engines and rocket engines.

In the jet engines, oxygen obtained from the surrounding atmosphere for combustion process. In the rocket engines, the propulsion unit consists of own oxygen supply for combustion purpose.

14. What are the classifications of rocket engine?

Rocket engine classified as follows:

- Chemical rocket engines
- Nuclear rocket engines
- Electrical rocket engines
- Solar rocket engines

15. What is under expanded nozzle?

It is a nozzle which discharges fluid at exit pressure greater than external pressure, because the exit area is too small.

16. What is over expanded nozzle?

It is a nozzle which discharges fluid at exit pressure lower than external pressure, because the exit area is too large.

17. What are the advantages of conical nozzle?

- It has simple configuration
- It is relatively easy to fabricate.

18. Define effective speed ratio.

It is the ratio of speed of flight to velocity of jet.

19. In rocket engine, how the propulsive efficiency varies with respect to speed ratio?

In rocket engine, if the speed ratio is increased, the propulsive efficiency is also increased and reaches maximum value when the speed ratio is unity. After that, the propulsive efficiency is decreased with increase in speed ratio.

20. What is weight flow ratio?

It is the ratio of propellant flow rate to the throat force.

CHEMICAL ROCKETS

1. What are the disadvantages of liquid propellant rocket engine?

- Manufacturing cost is high.
- High vibration
- The size and weight of the engine is more compared to solid propellant rocket.

2. What are the types of propellant feed system?

- Gas pressure feed system
- Pump feed system

3. What are the basic combustion processes?

- Injection
- Atomization
- Mixing
- Ignition
- Chemical reaction between fuel and oxidizer.

4. What are the advantages of solid propellant rocket engine?

- Simple in design and construction
- Less vibration due to absence of moving parts
- Less maintenance

5. What are the disadvantages of solid propellant rocket engine?

- It is difficult to stop the engine
- Low specific impulse
- Decrease of speed is not possible

6. What is the limitation of hybrid rocket engine?

In the hybrid rocket engine, the nozzle erosion cannot be avoided.

7. What are the advantages of hybrid rocket engine?

- Speed regulation is possible by regulating the supply of oxidizer
- High load capacity
- High fuel density
- Lighter compared to liquid propellant rockets

8. What is the use of strand burner?

Strand burner is used to measure the burning rate of the solid propellant.

9. What is cold gas propellant?

A cold gas propellant is stored at very high pressure gives a low performance allows a simple system and is usually very reliable. It has been used for roll control and altitude control.

10. What is gelled propellant?

A gelled propellant is a thixotropic liquid with a gelling additive. It behaves like a jelly or thick paint. It will not spill or leak. Readily can burn flow under pressure will burn and is safer in some respects.

11. Define Mixture ratio.

The propellant mixture ratio for a bipropellant is the ratio at which the oxidizer and fuel are mixed and react to give hot gases.

12. Define heterogeneous propellants.

In heterogeneous propellants solid propellants plastics, polymers and polyvinylchloride are used as fuels. Nitrates and perchlorates are used as oxidizer.

13. Define homogeneous propellants.

In homogeneous propellants solid propellants nitroglycerine and nitrocellulose are used. It combines the properties of fuels and oxidizer.

14. Define burning rate.

The velocity at which a solid propellant is consumed during operation is called the burning rate.

15. What is monopropellant?

A liquid propellant which contains both the fuel and oxidizer in a single chemical is known as monopropellant.

16. What is bipropellant?

If the fuel and oxidizer are different from each other in its chemical nature then the propellant is called bipropellant.

17. Classify the rocket engine based on source of energy employed?

Rocket engine can be classified as

- chemical rocket engine
- solar rocket engine
- nuclear rocket engine
- Electrical rocket engine.

18. What are the factors increase the burning rate?

- Combustion chamber pressure
- Initial temperature of the solid propellant prior to operation
- Combustion gas temperature
- Velocity of gas flow parallel to the burning surface
- Motor motion

19. What are the components of liquid propellant rocket engine?

- Tanks for storing liquid fuel and oxygen
- Preheater
- Combustion chamber and nozzle

20. What the conditions of maximum propulsive efficiency?

The jet velocity must be twice more than the free stream velocity for which the propulsive efficiency is 66.7%.

ADVANCED PROPULSION TECHNIQUES

1. What are the disadvantages of pulsed plasma electrical propulsion system?

- Low thrust
- Teflon reaction products are toxic
- Corrosive

2. What are the advantages of steady state plasma electromagnetic propulsion system?

- Can be relatively simple

- High specific impulse
 - High thrust per unit area
3. What are the disadvantages of steady state plasma electromagnetic propulsion system?
- Difficult to stimulate analytically
 - High specific power
 - Heavy power supply
4. What are the advantages of Hall thruster?
- Desirable Isp range
 - Compact relatively simple power conditioning
 - Inert propellant
5. What are the disadvantages of Hall thruster?
- Single propellant
 - High beam divergence
 - Erosion.
6. What are the requirements for solar sail powered spacecraft?
- Continuous force exerted by sunlight
 - A large ultrathin mirror
 - A separate launch vehicle.
7. What are the types of electrical rocket engines?
- Arc plasma rocket engine
 - Ion rocket engine
 - Magneto- plasma rocket engine.
8. What are the components in Arc plasma rocket engine?
- Propellant tank
 - Combustion chamber
 - Cooling system
 - Electric power supply.
9. What are the components in Magneto- plasma rocket engine?
- Propellant tank
 - Propellant pump

- Thrust chamber
- Accelerator.

10. What are the components in Ion rocket engine?

- Propellant tank
- Thrust chamber
- Electric power supply
- Vapourizing chamber.

11. Write down three fuel – oxidizer combination for hybrid propellant rockets?

- Beryllium hydride – Fluorine
- Lithium hydride – chlorine trifluoride
- Hydrocarbon – Nitrogen tetroxide
- Lithium hydride – Nitrogen tetroxide

12. What are the advantages of hybrid propellant rockets engine?

- Speed regulation is possible by regulating the supply of oxidizer.
- High load capacity.
- Hybrid rockets are lighter when compared to the liquid propellant typerocket.
- Higher fuel density.

13. What are the methods for ion generation?

There are three methods for ion generation. They are

- Surface contact
- Electron bombardment and
- Electric arc.

14. What are the advantages of electrical propulsion system?

- Simple device and easy to control
- Simple power containing
- Low cost and relatively high thrust and efficiency
- Can use many propellants including hydrazine augmentation.

15. What are the disadvantages of electrical propulsion system?

- Lowest Isp, , heat loss
- Dissociation of gas

- Indirect of heating of gas and erosion.

16. What are the advantages of arc jet propulsion system?

- Direct heating of gas.
- Low voltage
- Relatively simple device and high thrust.
- Can use catalytic hydrazine augmentation inert propellant.

17. What are the disadvantages of arc jet propulsion system?

- Low efficiency
- Erosion at high power and low specific impulse
- High current, heavy wiring, heat loss
- More complex power conditioning.

18. What are the advantages of ion jet propulsion system?

- High specific impulse
- High efficiency
- Inert propellant.

19. What are the disadvantages of ion jet propulsion system?

- Complex power conditioning and heavy power supply
- High voltage, single propellant only
- Low thrust per unit area.

20. What are the advantages of pulsed plasma electrical propulsion system?

- Simple device and low power.
- Because of solid propellants, no need of gas or liquid feed system and there is no zero gravity effects on propellants.