Review Questions

Introduction to Propulsion:

1. Who was the first person to illustrate the concept of jet propulsion? Describe the various features with the help of a diagram.
2. What was the progress made in the development of aircraft engines during 1700-1900 AD?
3. What were the main contributions of the British engineer, Sir Frank Whittle to the gas turbine engine?
4. When did the first supersonic engine fly?
5. What is the difference between a rocket and a gas turbine engine?
6. How is a piston engine different from a gas turbine engine?
7. How is a ramjet engine different from a gas turbine engine?
8. What is meant by pulse detonation engine? How is it different from a jet engine?
9. How is a turbojet engine different from a turbofan engine?
10. How is a turboprop engine different from a turbofan engine?
11. Enumerate the relative advantages and disadvantages among turbojet, turbofan and turboprop engines?
12. What are the different applications of gas turbine engines?

Review of Basic Principles:

1. What do you mean by calorically perfect gas? Explain it invoking kinetic theory of gas. Can it be employed for analysis of components of a gas turbine engine?
2. Draw the variation of specific heats of mono-, di- and tri-atomic species with temperature and explain the difference among the three types of species.
3. State First Law of Thermodynamics. What are the limitations of this law? Derive an expression for First Law of Thermodynamics for a control volume system by stating the assumptions.
4. Why is Second Law of Thermodynamics important for analysis of various component of a gas turbine engine?
5. What do you mean by Clausius Equation? How can it be utilized for analysis of a gas turbine engine?
6. What do you mean by compressible flow? How does it differ from incompressible flow?
7. Explain why is it desirable to locate normal shock at the throat of a CD nozzle.
8. What is difference between compression and expansion wave in a compressible flow?
9. When does a compression wave change into a shock wave?
10. What do you mean by shock strength? Explain it physically. Derive an expression for shock strength.

11. What is choking? Why does it occur? When a nozzle is choked, is there any way to change its mass flow rate? Elaborate.
12. If the shock appears over two dimensional wedge and axi-symmetric cone with same cone angle for same flow Mach number, then in which case would shock losses be minimum? Explain why is it so?

13. What is thermal chocking?
14. What is Rayleigh flow? When will it occur? Provide two practical examples. Derive an expression for exit Mach number for one dimensional Rayleigh flow.
15. Draw a Rayleigh line on T-s plane describing the processes involved.
16. What is Fanno flow? When will it occur? Provide two practical examples. Derive an expression for exit Mach number for one dimensional Rayleigh flow.
17. Show that upper and lower curves of Fanno flow represent subsonic and supersonic flows, respectively. Prove that flow becomes sonic at maximum entropy point.
18. What do you mean by laminar flow? How is it different from turbulent flow?
19. Why does the boundary layer develop whenever flow takes place over solid surface? Define boundary layer thickness for laminar flow.
20. Draw the boundary layer growth over a flat plate covering all three regimes of flow.

Elements of Propulsive engines:

1. What do you mean by specific thrust? Why is it used widely instead of thrust? How is it related to TSFC?
2. How is TSFC related to ηo for generic gas turbine engine?
3. How can static thrust be enhanced for a particular engine configuration?
4. Derive the expression for thrust for a turbofan engine.
5. Why is the propulsive efficiency of turboprop engine higher than that of turbojet engine?
6. Why is takeoff thrust for turboprop engine higher than that for turbojet engine?
7. What do you mean by BSFC? Why is it used for turboprop engine?
8. What are the differences between turbojet and turbofan engines?
9. Enumerate the differences between turbojet and turbojet engines.
10. Show the velocity of Ts, TSFC and η_p with flight speed for turbojet and turboprop engines.
11. For an ideal reheat gas turbine cycle, derive an expression for pressure ratio in terms of reheat temperature and inlet temperature at maximum specific work output.

Elements of Combustion:

Why is it used very often while dealing with a gas turbine engine?

1. What do you mean by equivalence ratio?
2. Can ideal gas law be used for modeling combustion problems? Why is it so?
3. What is heat of reaction? How is it different from heat of combustion?
4.
5. What do you mean by adiabatic flame temperature? How can it be estimated? Explain using an example.
6. Draw the variation of adiabatic flame temperature with equivalence ratio for C3H8-air mixture at ambient temperature and pressure.
7. How does the adiabatic flame temperature vary with increase in initial temperature? Why is it so? Explain it by providing proper argument.
8. Enumerate the procedure to estimate adiabatic flame temperature under constant volume condition.
9. What do you mean by global reaction chemistry. Explain it considering an example.

10. What do you mean by order of reaction? How is it different from molecularity?
11. What do you mean by premixed flame ? How is it different from diffusion flame?
12. Derive a relationship for burning velocity?
13. What do you mean by flame thickness? Derive a relationship for flame thickness in terms of burning velocity.
14. By using phenomenological method, derive a relationship for flame length.
15. How is the diameter of droplet receded with time? Derive an expression for it.

Cycle analysis of air breathing systems,

1. What is meant by on-design cycle analysis? Why is it important?
2. What is meant by off-design cycle analysis? How is it different from on-design cycle analysis?
3. What is meant by rubber engine? What kind of cycle analysis is carried out for such kind of an engine?
4. What are the applications of the ramjet engine?
5. Why cannot the ramjet engine produce static thrust? Suggest methods to modify a ramjet engine such that it can produce static thrust itself.
6. Which component in a ramjet dictates the performance of the engine? Why is it so?
7. Express the thermal efficiency of a ramjet engine in terms of τ_r.
8. Derive an expression for propulsive efficiency in terms of τ_r and τ_λ for a ramjet engine.
9. How does the mass flow rate per unit intake area of a ramjet engine vary with flight Mach number?
10. How is the turbojet engine different from the ramjet?
11. For flight Mach number of 2.0, if one has to choose between ramjet and turbojet engines to achieve minimum TSFC, which one should be preferred and why?
12. Define TSFC for a turbojet engine. Why is it considered to be a good parameter to compare engine efficiencies?
13. What are the factors that affect the overall efficiency of a turbojet engine?
14. How does a pilot control the thrust in a turbojet engine?
15. Which component in a turbojet dictates the performance of the turbojet? Why is it so?
16. What is bypass ratio? Why is it so important?
17. How does the bypass ratio affect the thermal efficiency and propulsive efficiency?
18. What are the advantages and disadvantages of using high bypass ratio in a turbofan engine?
19. How does the thrust of a particular turbofan engine vary with flight Mach number? Discuss it.
20. How does the thrust of high bypass turbofan engine get affected by an increase in altitude and flight speed?
21. Can you call turboprop engine as ultrahigh bypass ratio turbofan engine? If yes, why?
22. Define work output coefficient for propeller and core engine? How is it related to the thrust generated by the propeller and core engine?

Rocket engines:

1. Explain the operating principle of a rocket engine.

2. What are the different categories of rocket engines that are employed for space propulsion?
3. Show that, for a chemical rocket engine the propulsive efficiency is maximum when the flight velocity is equal to the effective jet velocity?
4. What is the difference between total impulse and specific impulse of a rocket engine?

5. How does the mass flow coefficient relate to the characteristic velocity?
6. What is the difference between mass flow coefficient and thrust coefficient?.

7. Define mass ratio and propellant mass fraction of a chemical rocket stage and derive a relation between them.
8. Show that the exit velocity from a CD nozzle is a function of chamber parameters and exit pressure.
9. What do you mean by mass flow coefficient and characteristics velocity? Express them in terms of critical flow factor of the rocket nozzle.
10. What are the advantages of solid propellant rockets over liquid propellant engine?
11. Compare the features of a solid propellant engine with a liquid propellant engine.
12. Why is cooling required for combustion chamber and nozzle in liquid propellant rocket? What are cooling methods employed in liquid propellant engine?
13. What are the kinds of hybrid engines possible in realm of chemical propulsion engines.
14. What are the factors to be considered for selecting bipropellant in a liquid rocket engine?
15. What do you mean by linear burning rate of a solid propellant.
16. How does thrust varies with time in neutral burning grain?
17. What are the differences among regressive, neutral and progressive burning as applied to solid propellant combustion.
18. What are the various methods of ignition employed in liquid propellant rockets?
19. What is the function of injector in liquid rocket engines? Describe two injectors for hypergolic propellant.