5th Semester	RAE5C003	Aerospace Propulsion	L-T-P 3-0-0	3 CREDITS

COURSE OUTCOMES

1. Understand the internal flow inlets.
2. Know the types and working principles of compressors
3. Understand the types and working methods in combustion chambers and the flow through nozzle
4. The solid and liquid propellant rocket operating principles and components
5. About electric, ion and nuclear rockets. The basics of solar sails and its operating principle.

Module I: DIFFUSER **5hrs**

Subsonic inlet and Internal flow, Major features of external flow, Relation between minimum area ratio and external deceleration ratio, Supersonic inlets, Starting problem on supersonic inlets, Shock swallowing by area variation, External deceleration, Modes of inlet operation.

Module II: COMPRESSOR **7hrs**

Working principle of axial compressor, Elementary theory, Velocity triangles, Degree of reaction, Three dimensional flow, Compressor blade design & stage performance calculation, Factors affecting stage pressure ratio , off design performance, Axial compressor performance characteristics. Working principle of centrifugal compressor, Work done and pressure rise, Inducer and impellor, Velocity diagrams, Centrifugal compressor performance characteristics.

Module III: COMBUSTION CHAMBERS and NOZZLES **10hrs**

Classification of combustion chambers, Important factors affecting combustion chamber design, Combustion process, Combustion chamber performance, Effect of operating variables on performance, Flame stabilization, Use of flame holders, Numerical problems.

Theory of flow in isentropic nozzles, nozzle choking, Nozzle throat conditions, Nozzle efficiency, Losses in nozzles, Over expanded , under expanded nozzles , Ejector and variable area nozzles. Working principle of afterburner, afterburner augmentation, Thrust and efficiency,

Module IV: RAMJET PROPULSION: 5hrs

Operating principle, Sub critical, critical and supercritical operation, Combustion in ramjet engine, Ramjet performance, Simple ramjet design calculations, Introduction to scramjet.

Module – IV ROCKET PROPULSION 10hrs

Specific impulse of a rocket, internal ballistics, Rocket nozzle, classification, Rocket performance considerations, Solid propellant rockets, Selection criteria of solid propellants, Important hardware components of solid rockets, Propellant grain design considerations, Liquid propellant rockets, Selection of liquid propellants. Cooling in liquid rockets, Hybrid rockets. Electric rocket propulsion, Ion propulsion techniques, Nuclear rocket, Types – Solar sail, Preliminary Concepts in nozzleless propulsion.

Books

1. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Addison – Wesley Longman INC, 1999.
2. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edn., 1993.
3. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Addison – Wesley Longman INC, 1999.
4. Cohen, H. Rogers, G.F.C. and Saravana muttoo, H.I.H. "Gas Turbine Theory", Longman, 1989.
5. Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAA Education Series, New York, 1985.
6. Cohen, H., Rogers, G.F.C. and Saravanamuttoo, H.I.H., "Gas Turbine Theory", Longman Co., ELBS Ed., 1989.
7. Gorden, C.V., "Aero thermodynamics of Gas Turbine and Rocket Propulsion", AIAA Education Series, New York, 1989.

Digital Learning Resources

Course Name:	Aerospace Propulsion
Course Link:	https://nptel.ac.in/courses/101/104/101104007/
Course Instructor:	Mr. Yogendra Singh, Dr. A.K. Ghosh, Dr. Deepu Philip IIT Kanpur
Course Name:	Introduction to Aerospace Propulsion
Course Link:	https://nptel.ac.in/courses/101/101/101101001/
Course Instructor:	Prof. Bhaskar Roy, Prof. A M Pradeep, IIT Bombay