SAE1306	HEAT TRANSFER TECHNIQUES FOR AEROSPACE APPLICATIONS	L	T	P	C	Total Marks
		3	1	0	4	100

COURSE OBJECTIVES:

The aim of the course is to:

- To impart knowledge on various modes of heat transfer and methods of solving problems.
- To give exposure to numerical methods employed to solve heat transfer problems.

COURSE OUTCOMES:

At the end of the course, the students will be able to:

CO1: Compare the various modes of heat transfer and analyse the conduction heat transfer in various systems in both steady and unsteady state conditions

CO2: Distinguish natural and forced convection phenomena and measure the heat transfer coefficient in external and internal fluid flow problems.

CO3: Apply the laws of radiation, analyse the radiation exchange between surfaces and the effect of radiation shields

CO4: Discriminate the types of heat exchangers and design the heat exchanger with LMTD and NTU approach

CO5: Describe the principles of high-speed flow heat transfer and analyse the heat transfer problems in gas turbine combustion chamber

CO6: Describe the application of high-speed flow heat transfer in aerospace components and analyse the heat transfer by numerical methods.

COURSE SYLLABUS:

UNIT : 1 INTRODUCTION AND CONDUCTION HEAT TRANSFER **12 hrs**

Basic modes of heat transfer – One dimensional steady state heat conduction – Cartesian, cylindrical and spherical coordinates – Composite medium – Critical thickness – Effect of variation of thermal conductivity – Extended surfaces. Conduction with heat generation. Unsteady state heat conduction – Heat transfer analysis of Lumped system, Semi infinite and infinite solids – Use of Transient-Temperature charts - Applications of numerical techniques.

UNIT : II CONVECTIVE HEAT TRANSFER **12 hrs**

Introduction-Forced convection-Development of velocity and thermal boundary layer by a flow on a vertical flat plate – Laminar and turbulent convective heat transfer analysis in flows over a flat plate, circular pipe and spherical surface. Free convective heat transfer over vertical flat plate, cylinders and spheres – Empirical relations , applications of numerical techniques in problem solving.

UNIT : III RADIATIVE HEAT TRANSFER **12 hrs**

Introduction – Physical mechanism of radiation – Radiation properties – Characteristics of surfaces- Emissivity – Radiation shaper factor – Heat exchange between non-black bodies – Radiation shields

UNIT : IV HEAT EXCHANGERS **12 hrs**

Classification of heat exchangers – Temperature distribution – Overall heat transfer coefficient – Heat exchange analysis – LMTD Method and E-NTU Method.

UNIT : V HIGH SPEED FLOW HEAT TRANSFER MASS TRANSFER **12 hrs**

High-Speed flow heat transfer - Heat transfer problem in gas turbine combustion chamber-ablative heat transfer Aerodynamic heating – Rocket thrust chambers - Numerical treatment. Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion –Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.

TEXT / REFERENCE BOOKS

1. Holman J.P, "Heat Transfer", McGraw-Hill Book Co., Inc., New York, 6th Edition, 1991.
2. Yunus A. Cengel, Heat Transfer – A Practical Approach Tata McGraw Hill Edition, 2003
3. S.C. Sachdeva, "Fundamentals of Engineering Heat & Mass Transfer", Wiley Eastern Ltd., New Delhi, 1981.
4. John H. Lienhard, "A Heat Transfer Text Book", Prentice Hall Inc., 1981.
5. MathurM.Sharma, R.P., "Gas Turbine and Jet and Rocket Propulsion", Standard Publishers, New Delhi, 1988

SAE1307	AEROSPACE PROPULSION	L	T	P	Credits	Total Marks
	(For Aeronautical)	2	1	0	3	100

COURSE OBJECTIVES

To impart knowledge in non-air-breathing and hypersonic propulsion methods to students so that they are familiar with various propulsion technologies associated with space launch vehicles, missiles and space probes.

COURSE OUTCOMES

CO1: Design of the ramjet engine and scramjet engine ducts and performance calculations.
CO2: Determine the specific impulse of a rocket engine and internal ballistics of rocket performance.
CO3: Inspect the ignition system and injector used for propellant feed systems for rocket engine.
CO4: Select the appropriate type of propellants for solid, liquid and hybrid rocket engine.
CO5: Interpret the electric and ion propulsion functions used for interplanetary motion.
CO6: Utilize the solar sail, nuclear rocket and nozzle less propulsion for interplanetary motion.

UNIT 1 RAMJET PROPULSION 9 Hrs.

Operating principle – Subcritical, critical and supercritical operation – Combustion in ramjet engine – Ramjet performance – Sample ramjet design calculations – Introduction to scramjet– Preliminary concepts in supersonic combustion – Integral ram- rocket- Numerical problems.

UNIT 2 FUNDAMENTALS OF ROCKET PROPULSION 9 Hrs.

Operating principle – Specific impulse of a rocket – internal ballistics- Rocket nozzle classification – Rocket performance considerations – Numerical Problems.

UNIT 3 ROCKET SYSTEM 9 Hrs.

Ignition System in rockets – types of Igniters – Igniter Design Considerations – Design Consideration of liquid Rocket Combustion Chamber, Injector Propellant Feed Lines, Valves, Propellant Tanks Outlet and Helium Pressurized and Turbine feed Systems – Propellant Slosh and Propellant Hammer

UNIT 4 CHEMICAL ROCKETS 9 Hrs.

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 – Thrust control in liquid rockets – Cooling in liquid rockets – Limitations of hybrid rockets – Relative advantages of liquid rockets over solid rockets- Numerical Problems.

UNIT 5 ADVANCED PROPULSION TECHNIQUES TURBINES 9 Hrs.

Electric rocket propulsion – Ion propulsion techniques – Nuclear rocket – Types – Solar sail-Preliminary Concepts in nozzle less propulsion. Introduction to turbine analysis, mean radius stage calculations, stage parameters, stage loading and flow coefficients degree of reaction, stage temperature ratio and pressure ratio, blade spacing, radial variation, velocity ratio. Axial flow turbine, stage flow path, Dimensional stage analysis.

Max. 45 Hours

TEXT / REFERENCE BOOKS

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

1989.
5. Mathur, M., and Sharma, R.P., "Gas Turbines and Jet and Rocket Propulsion", Standard Publishers, New Delhi, 1988.

SAE1308	AIRCRAFT DESIGN (For Aeronautical)	L	T	P	Credits	Total Marks
		2	1	0	3	100

COURSE OBJECTIVES

To get clear cut idea about aerodynamic design, aircraft structural design and power plant design

COURSE OUTCOMES

CO1: Identify the type of aircraft design specifications and estimate the overall takeoff weight.
CO2: Calculate the design load factor for cruise and stall conditions of the aircraft to be designed.
CO3: Plot the shear force and bending moment diagram for the aircraft wing to be designed.
CO4: Select the appropriate power plant for the aircraft to be designed and estimation of thrust.
CO5: Design of supersonic aircraft wings and its optimization technique to achieve the desired performance.
CO6: Interpret the design features of V/STOL and rotary wing aircrafts.

UNIT 1 PRELIMINARY DESIGN 11 Hrs.

Introduction, Aircraft Design Requirements, specifications, role of users, Aerodynamic and Structural Consideration, Importance of weight. Airworthiness requirements and standards. Classifications of airplanes. Special features of modern airplane, Airplane Weight Estimation, Weight estimation based on type of airplane, trends in wing loading, weight-estimation based on mission requirements, iterative approach.

UNIT 2 AERODYNAMIC DESIGN AND PERFORMANCE 10 Hrs.

Basics of Wing Design, Selection of airfoil selection, influencing factors. Span wise load distribution and plan form shapes of airplane wing. Stalling, take-off and landing considerations. Wing drag estimation. High lift devices, Air Loads in Flight, Symmetrical measuring loads in flight, Basic flight loading conditions, Load factor, Velocity - Load factor diagram, gust load and its estimation, Structural limits.

UNIT 3 STRUCTURAL DESIGN 10 Hrs.

Cockpit and aircraft passenger cabin layout for different categories, types of associated structure, features of light airplanes using advanced composite materials, Structural aspects of design of airplane, Bending moment and shear force diagram. Design principles of all metal stressed skin wing for civil and military applications.

UNIT 4 POWER PLANT DESIGN 7 Hrs.

Estimation of Horizontal and Vertical tail volume ratios. Choice of power plant and various options of locations, considerations of appropriate air –intakes. Integration of wing, fuselage, empennage and power plant. Estimation of center of gravity.

UNIT 5 ADVANCED DESIGN CONCEPTS 7 Hrs

Supercritical Wings, relaxed static Stability, controlled configured vehicles, V/STOL aircraft and, rotary wing vehicles. Layout peculiarities of supersonic aircraft – optimization of wing loading to achieve desired performance – loads on undercarriages and design requirements. Categories and types of aircrafts – various configurations – Layouts and their relative merits – strength, stiffness, fail safe and fatigue requirements – Manoeuvering load factors – Gust and manoeuverability envelopes – Balancing and maneuvering loads on tail planes.

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. Raymer D.P. "Aircraft Conceptual design", AIAA Series, 1988.
2. Corning G. "Supersonic & Subsonic Airplane Design", II Edition, Edwards Brothers Inc., Michigan, 1953.
3. Bruhn E.F, "Analysis and Design of Flight Vehicle Structures", Tristate Offset Co., U.S.A., 1980.
4. Torenbeek E, "Synthesis of Subsonic Airplane Design", Delft University Press, London, 1976.

5. Lebedenski A.A, "Notes on airplane design", Part-I, I.I.Sc., Bangalore

SAE4057	PROPULSION LAB (For Aeronautical)	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: Estimate the flash point and fire point of the aviation fuel.

CO2: Evaluate the characteristics of free jet, wall jet and axial flow compressor.

CO3: Demonstrate the pressure distribution of Convergent and Divergent Nozzle.

CO4: Perform the study of Aircraft piston and Turbojet engine

CO5: Evaluate the free and forced convection heat transfer.

CO6: Elucidate the performance of Gas turbine Engine

SUGGESTED LIST OF EXPERIMENTS

1. Determination of heat of combustion of aviation fuel.
2. Determination of free jet characteristics and velocity profile.
3. Determination of wall jet characteristics and velocity profile.
4. Determination of axial flow compressor performance.
5. Estimation of pressure distribution in Convergent nozzle passage. Modeling of Pulse jet Engine
6. Estimation of pressure distribution in Divergent nozzle passage. Computational Methods in Propulsion
7. Study of Aircraft piston and Turbojet engine propeller.
8. Study of free convective heat transfer over a square plate.
9. Study of forced convective heat transfer over a cylindrical duct.
10. Evaluation of performance of Gas turbine Engine.