ACADEMIC CURRICULA

Professional Core Courses

AEROSPACE ENGINEERING

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18ASC101T	Course Name	APPLIED ENGINEERING MECHANICS	Course Category	C	Professional Core	L	T	P	C
							3	1	0	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Utilize the concept of equilibrium of particles and rigid bodies*
CLR-2 :	*Utilize the concept of finding centroid of planar figures and moment of inertia about different axes*
CLR-3 :	*Utilize with the dynamics of particles*
CLR-4 :	*Utilize with the dynamics of rigid bodies*
CLR-5 :	*Apply the concepts of mechanics to solve problems related to space mechanics*
CLR-6 :	*Utilize the concepts in better understanding of systems dealing with forces*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	*Determine the forces under equilibrium*	2	85	75	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*Identify the centroids and determine moment of inertia*	2	85	75	H	H	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	*Determine the forces acting on particle both kinetics and kinematics*	2	85	75	H	-	H	H	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*Determine the forces acting on rigid body both kinetics and kinematics*	2	85	75	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	*Application of determining space orbit*	2	85	75	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	*Apply the concepts of fundamental mechanics and space mechanics in real time applications*	2	85	75	H	H	H	H	-	-	-	-	-	-	-	-	-	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Fundamentals of mechanics- Classification of forces, Laws of mechanics.*	*Determination of centroids by integration, centroids of lines, areas and volumes.*	*Rectilinear motion-Uniform motion andRectangular components of velocity*	*Kinematics of rigid bodies*	*Curvilinear motion: Projectile motion*
	SLO-2	*Vector and vector operations problems*	*Determination of centroids by integration, centroids of areas*	*Rectilinear motion - Uniformly accelerated motion*	*Kinematics of rigid bodies: Linear translational motion*	*Projectile motion: Path of the projectile*
S-2	SLO-1	*Forces on particles in 2 D- Triangular law of forces & parallelogram law of forces*	*Determination of centroids in composite areas*	*Curvilinear motion-Normal and tangential components*	*Kinematics of rigid bodies: Fixed axis rotation*	*Position and velocity of the projectile after a known time*
	SLO-2	*Equilibrium on particles in 2D, Lami's Theorem, Free body diagram*	*Centroids of volumes, Centre of gravity*	*Curvilinear motion- Normal and tangential components*	*Kinematics of rigid bodies: Fixed axis rotation*	*Velocity, direction and time taken of the projectile after a known height*
S-3	SLO-1	*Action & Reaction, Equilibrium on particles in 2 D – Equations of Equilibrium*	*Pappus guildinus Theorem I*	*Curvilinear motion- Radial and transverse components*	*Kinematics of rigid bodies: relation between linear and rotation*	*Motion of particle projected horizontally*
	SLO-2	*Forces in space*	*Pappus guildinus Theorem II*	*Curvilinear motion- Radial and transverse components*	*Kinematics of rigid bodies: relation between linear and rotation*	*Projected from inclined plane*
S-4	SLO-1	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
	SLO-2	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
S-5	SLO-1	*Statics of rigid body in 2D – Moment & Varigon's Theorem*	*Moment of inertia*	*Cylindrical coordinates- Newtons second law, D'Alembert's principle.*	*General plane motion-Absolute and relative velocity in plane motion*	*Angular momentum of a particle. Rate Of change of angular momentum*
	SLO-2	*Statics of rigid body in 2D – Force Couple System*	*Determination of moment of inertia by Integration*	*Cylindrical coordinates- Newtons second law, D'Alembert's principle.*	*General plane motion-Absolute and relative velocity in plane motion*	*Motion under a central force, Conservation of angular momentum.*

S-6	SLO-1	*Equilibrium of Rigid bodies in 2D*	*Parallel axis theorem*	*Principle of work and energy*	*General plane motion: Crank- Rod Mechanism*	*Newton's Law of Gravitation*
	SLO-2	*Equilibrium of Rigid bodies in 2D : Support Reactions, Types of Support*	*Parallel axis theorem*	*Principle of work and energy*	*General plane motion: Crank- Rod Mechanism*	*Sample problems: Conservation of angular momentum and newton's law of gravitation*
S-7	SLO-1	*Analytical method to determine the support reactions of beam*	*Perpendicular axis theorem*	*Principle of impulse and Momentum.*	*Instantaneous centre of rotation in plane motion*	*Sample problems: Conservation of angular momentum and newton's law of gravitation*
	SLO-2	*Moment of Uniformly varying loads*	*Perpendicular axis theorem*	*Principle of impulse and Momentum.*	*Instantaneous centre of rotation in plane motion*	*Sample problems: Conservation of angular momentum and newton's law of gravitation*
S-8	SLO-1	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
	SLO-2	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
S-9	SLO-1	*Truss: Classification, perfect/Imperfect frame, Analysis of perfect frame*	*Polar moment of inertia,*	*Impact of Elastic bodies*	*D'Alembert's principle : Linear motion*	*Trajectory of a particle under a central force*
	SLO-2	*Determine the support Reaction in truss*	*Radius of gyration*	*Derivation of Elastic coefficient*	*D'Alembert's principle : Rotation motion*	*Trajectory of a particle under a central force: Application to space mechanics*
S-10	SLO-1	*Analysis of perfect Frame by method of joints: Simply supported*	*Mass moment of inertia of solid objects*	*Impact of Elastic bodies-Direct central*	*Principle of work and energy for a rigid body : Linear motion*	*Kepler Law of planetary motion*
	SLO-2	*Analysis of perfect Frame by method of joints: Cantilever*	*Mass moment of inertia of solid objects*	*Impact of Elastic bodies-Direct central*	*Principle of work and energy for a rigid body: Rotation motion*	*Sample problems: Central force*
S-11	SLO-1	*Analysis of perfect Frame by method of sections: Simply supported*	*Mass Moment of inertia of thin plates*	*Impact of Elastic bodies- Oblique central impact.*	*Principle of impulse, momentum for plane motion of a rigid body: Linear motion*	*Sample problems: Central force*
	SLO-2	*Analysis of perfect Frame by method of sections: Cantilever*	*Mass Moment of inertia of thin plates*	*Impact of Elastic bodies- Oblique central impact.*	*Principle of impulse, momentum for plane motion of a rigid body: Rotation motion*	*Sample problems: Periodic time*
S-12	SLO-1	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
	SLO-2	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*

Learning Resources	1. *Ferdinand P. Beer, E. Russell Johnston Jr., David Mazurek, Phillip J Cornwell, Vector Mechanics for Engineers: Statics and Dynamics, 10th ed., McGraw Hill, 2013* 2. *Shames, I.H., Krishna Mohana Rao, G., Engineering Mechanics (Statics and Dynamics), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 2006*	3. *NPTEL Engineering Mechanics Lectures by IIT Guwahati 'https://nptel.ac.in/courses/112103109/'*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Raja, National Aerospace Laboratories, Bangalore, raja@nal.res.in	*1. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	*1. Mr. K. B. Ravichandrakumar, SRMIST*
2. Dr. Vinay Kumar Gupta, National Physical Laboratory, guptavinay@nplindia.org	*2. Dr. S. Elangovan, BIHER,Chennai, email : subelango@yahoo.co.in*	*2. Mr. Iynthezhuthon, SRMIST*

Course Code	18ASC102J	Course Name	APPLIED FLUID MECHANICS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Identify the characteristics of fluids and utilize the pressure measuring devices*
CLR-2 :	*Solve the basic fluid flow problems and apply the system and control volume concept in various fluid flow problems*
CLR-3 :	*Identify the mathematical techniques of potential flow problems*
CLR-4 :	*Solve the basic dimensional analysis and fluid flow through pipes*
CLR-5 :	*Analyze the basic concepts of boundary layer in fluid flow*
CLR-6 :	*Explore advanced level of fluid mechanics applications*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	*Accrue the knowledge of fluid properties and principle and function of pressure measuring instruments*	*2*	*85*	*75*	*H*	*M*	*M*	*L*	-	-	-	-	*L*	-	-	*M*	*L*	-	-
CLO-2 :	*Analyze the fluid flow problems and system and control volume concept*	*2*	*85*	*75*	*H*	*H*	*M*	*M*	-	-	-	-	*L*	-	-	*M*	*L*	-	-
CLO-3 :	*Apply the mathematical techniques of potential flow problems*	*2*	*85*	*75*	*H*	*H*	*M*	*M*	-	-	-	-	-	-	-	*M*	-	-	-
CLO-4 :	*Apply the dimensional analysis and fluid flow through pipes*	*2*	*85*	*75*	*H*	*H*	*M*	*M*	-	-	-	-	*L*	-	-	*M*	*L*	-	-
CLO-5 :	*Accrue the knowledge about boundary layer concept*	*2*	*85*	*75*	*H*	*M*	*M*	*L*	-	-	-	-	-	-	-	*M*	-	-	-
CLO-6 :	*Accrue comprehensive knowledge in fluid mechanics applications*	*2*	*85*	*75*	*H*	*H*	*M*	*M*	-	-	-	-	*L*	-	-	*M*	*L*	-	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Introduction to fluid mechanics*	*Lagrangian and Eulerian description of fluid flow*	*Pitot – tube*	*Dimensional Analysis*	*Pipe friction major and Minor losses*
	SLO-2	*Brief history of fluid mechanics*	*Types of fluid flow, streamlines, path lines, and streak lines.*	*Numerical problems*	*Rayleigh's method, numerical problems*	*Numerical problems*
S-2	SLO-1	*Fluids and their properties*	*System and Control volume concept*	*Introduction to potential flow*	*Buckingham's Pi – theorem*	*Numerical Problems in parallel,*
	SLO-2	*Density, viscosity, surface tension*	*Introduction to Reynolds transport theorem*	*Equation of streamline*	*Buckingham's Pi – theorem procedure*	*Series and branched pipes.*
S-3	SLO-1	*Properties of fluids numerical problems*	*Reynolds transport theorem*	*Stream function, Velocity potential function*	*Numerical problems on Buckingham's Pi – theorem*	*Boundary layer theory introduction*
	SLO-2	*Compressibility and bulk modulus*	*Reynolds transport theorem and its applications*	*Basic elementary flows*	*Numerical problems*	*Fluid flow over bodies*
S 4-5	SLO-1 SLO-2	*Lab 1: Determine coefficient of discharge of orifice meter*	*Lab 4: Repeat class*	*Lab 7: Performance test on radial centrifugal air blower*	*Lab 10: Performance test on forward centrifugal air blower*	*Lab 13: Major loss due to friction in pipe flow*
S-6	SLO-1	*Fluid statics-Pascal's law*	*Reynolds transport theorem, applications in finite control volume analysis*	*Uniform parallel flow stream function and velocity potential function*	*Applications of important dimensionless numbers*	*Flow over a flat plate*
	SLO-2	*Numerical problems on Pascal's law*	*control volume analysis Numerical problems*	*Source flow and sink flow stream function and velocity potential function*	*Numerical problems*	*Boundary layer development on a flat plate*
S-7	SLO-1	*Hydrostatic law*	*Euler's equation of motion along a streamline*	*Free vortex*	*Flow through pipes*	*Displacement thickness, momentum thickness*

	SLO-2	*Piezometric head, and Numerical problems*	*Bernoulli's equation*	*Free vortex stream function and velocity potential function*	*Laminar and turbulent flow*	*Energy thickness*
S-8	SLO-1	*Manometry- simple manometer*	*Bernoulli's equation - Numerical problems*	*Forced vortex*	*Hagen - Poiseuille flow in circular pipes*	*Numerical problems on*
	SLO-2	*Numerical problems on simple manometers*	*Numerical problems on Bernoulli's equation*	*Combination of elementary flows*	*Hagen – Poiseuille equation*	*displacement thickness, momentum thickness, Energy thickness*
S 9-10	SLO-1	*Lab 2: Determine coefficient of discharge of venturimeter*	*Lab 5: Determine Impact force of water jet on vane*	*Lab 8: Repeat class*	*Lab 11: Determine type of flow by Reynolds apparatus*	*Lab 14: Performance test on reciprocating air compressor*
	SLO-2					
S-11	SLO-1	*Differential manometer- U-tube differential manometer*	*Bernoulli's equation – Application venturimeter, orifice meter, pitot tube*	*Doublet flow*	*Hagen – Poiseuille equation applications*	*Drag on a flat plate*
	SLO-2	*Numerical problems on U-tube differential manometer*	*Venturimeter discharge equation*	*Doublet flow stream function and velocity potential function*	*Numerical problems on viscous flow through pipes*	*Vonkarman Momentum integral equation*
S-12	SLO-1	*Differential manometer- Inverted U-tube differential manometer*	*Numerical problems on Venturimeter*	*Non-lifting flow over a cylinder*	*Development of flow in pipes Darcy-Weisbach equation*	*Separation of flow over bodies, streamlined and bluff bodies*
	SLO-2	*Numerical problems on Inverted U-tube differential manometer*	*Numerical problems on Venturimeter*	*Pressure and velocity distributions*	*Pipe friction*	*Lift and Drag on cylinder*
S-13	SLO-1	*Inclined manometer*	*Orifice meter*	*Lifting flow over a cylinder*	*Numerical problems on Darcy-Weisbach equation*	*Lift and Drag on Aerofoil*
	SLO-2	*Numerical problems on Inclined manometer*	*Orifice meter discharge equation, and numerical problems*	*pressure and velocity distributions*	*Numerical problems on Pipe friction*	*Lift and Drag on cylinder and Aerofoil Numerical problems*
S 14-15	SLO-1	*Lab 3: Verify Bernoulli's theorem*	*Lab 6: Minor losses due to pipe fittings in pipes*	*Lab 9: Performance test on backward centrifugal blower*	*Lab 12: Repeat class*	*Lab 15: Repeat class*
	SLO-2					

Learning Resources	1. *Kumar, K.L., Engineering Fluid Mechanics, 8th ed., S. Chand, New Delhi, 2016* 2. *Munson, Bruce R., Young, Donald F., Okiishi, Theodore H., Huebsch, Wade W. Fundamentals of Fluid Mechanics, 7th ed., John Wiley & Sons, Inc. 2016*	3. *Irving H. Shames, Mechanics of Fluids, 4th ed., McGraw-Hill, 2003* 4. *Streeter, Victor, Bedford, K.W., Wylie, E. Benjamin, Fluid Mechanics, 2nd ed., Tata McGraw Hill, New Delhi, 1997*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember / Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply / Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate / Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100%	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Raja, National Aerospace Laboratories, Bangalore, raja@nal.res.in	*1. Dr. S. Elangovan, BIHER,Chennai, email : subelango@yahoo.co.in*	*1. Mr. S. Rajkumar, SRMIST*
2. Dr. Vinay Kumar Gupta, National Physical Laboratory, guptavinay@nplindia.org	*2. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	*2. Mr. M. Abdur Rasheed, SRMIST*

Course Code	18ASC103T	Course Name	AERO ENGINEERING THERMODYNAMICS	Course Category	C	*Professional Core*	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Identify the engineering and practical applications of Heat, Energy and Work*
CLR-2 :	*Identify the applications of Thermodynamics on Engineering systems*
CLR-3 :	*Identify the significance of Thermodynamic Laws*
CLR-4 :	*Create insights to the concepts of Entropy and Exergy*
CLR-5 :	*Analyze the working principle of Heat Energy driven systems*
CLR-6 :	*Utilize the Thermodynamic concepts in physics for the broad understanding of engineering and technology*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Identify the laws of Thermodynamics and its applications to Aerospace Engineering*	*2*	*80*	*70*	*H*	*M*	*L*	*L*	-	-	-	-	-	-	-	*H*	-	-	-
CLO-2 :	*Comprehend the concept and applications of energy, entropy and exergy*	*2*	*80*	*70*	*H*	*M*	*M*	*M*	-	-	*L*	-	-	*L*	-	*H*	*M*	*M*	*M*
CLO-3 :	*Understand various gas and vapor power cycles with applications*	*2*	*80*	*70*	*H*	*M*	*L*	*M*	-	-	-	-	*L*	-	-	*H*	-	-	-
CLO-4 :	*Understand the gas mixture behavior and chemical reactions*	*2*	*80*	*70*	*H*	*M*	*M*	*M*	-	-	*M*	*M*	*M*	*M*	*L*	*H*	*M*	*M*	*M*
CLO-5 :	*Utilize the fundamental concepts for the physical understanding of engineering and technology*	*2*	*80*	*70*	*H*	*M*	*M*	*M*	*M*	*L*	*L*	-	*L*	*M*	*L*	*H*	*M*	*M*	*M*
CLO-6 :	*Apply the Thermodynamic Principles to Aerospace Engineering Applications*	*2*	*80*	*70*	*H*	*M*	*M*	*M*	*M*	*L*	*L*	*M*	*L*	*M*	*L*	*H*	*M*	*M*	*M*

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Basic Concepts: Microscopic,macroscopic point of view, Path and point functions.*	*Limitations of first law of Thermodynamics. Introduction to Heat Reservoirs, Sources and Sinks*	*Limitations of Second Law of Thermodynamics*	*Role of Carnot cycle in Aerospace engineering*	*Mass fraction and mole fractions*
	SLO-2	*Intensive and extensive, total and specific quantities.*	*Heat Engine, Refrigerator, and Heat pump. Thermal efficiency of heat engines.*	*Explanation of the Concept of Entropy*	*Introduction to Otto cycle, Diesel cycle, Dual cycle*	*p-v-t behavior and properties of ideal gas mixtures*
S-2	SLO-1	*System and types. Zeroth law of thermodynamics, Thermodynamic equilibrium*	*Second law of Thermodynamics: C.O.P, Kelvin-Planck statement*	*Clausius inequality, T-s diagram*	*Indicator diagram Mean effective pressure*	*Dalton's law of partial pressures, Avogadro's law*
	SLO-2	*Quasi-static, reversible and irreversible processes. Heat and work transfer, sign convention*	*Clausius statement of second law and equivalence of statements.*	*Entropy change for different processes.*	*Comparison of Otto, Diesel and Dual cycles, Air standard efficiency*	*Gibbs-Dalton law, enthalpy and specific heat of a gas mixtures*
S-3	SLO-1	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
	SLO-2	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*	*Solving Problems*
S-4	SLO-1	*First law of Thermodynamics: First law for a closed system undergoing a cycle, concept of Internal energy, change of state*	*Reversible and irreversible processes- causes of irreversibility*	*Principle of increase of Entropy, Maxwell relations, T-ds Equations, Difference and ratio of heat capacities*	*Introduction to Aerospace Propulsion - Brayton cycle*	*Chemical reactions, Combustion, Stoichiometric coefficients, Air-Fuel ratio, Equivalence ratio*
	SLO-2	*Energy and Work Transfer in closed*	*Carnot Theorem and corollary*	*Energy equation, Joule Thomson*	*Effect of Reheat, Regeneration and*	*Combustion and Dissociation*

		systems, P-V diagram, PMM1		Coefficient, Clausius-Clapeyron equation	Intercooling	
S-5	SLO-1	Solving Problems	Absolute Thermodynamic Temperature scale	Solving Problems	Solving Problems	Solving Problems
	SLO-2	Solving Problems	Carnot cycle and Performance	Solving Problems	Solving Problems	Solving Problems
S-6	SLO-1	First law for an Open system: Conservation of mass, energy, steady flow energy equation	Solving Problems	Entropy change of Ideal and Real gases	Turbine and Compressor efficiency	Aerospace Chemical Propulsion: Fuels in combustion
	SLO-2	Aerospace applications of SFEE to Nozzles, Diffusers	Solving Problems	Isentropic efficiencies of Aerospace steady flow devices	Factors affecting efficiency	Enthalpy of reaction, formation and combustion
S-7	SLO-1	Cases of turbine, compressor, boiler, pump	Engineering and Practical Applications of Second Law	Exergy in Aerospace Engineering: High and low-grade energy	Equivalent Carnot cycles: Stirling and Ericsson cycle, Humphrey cycle	Gravimetric and volumetric analysis
	SLO-2	Heat exchanger and Throttling process	Aerospace Engineering Applications of Second Law	Available and non-available energy of a source and finite body	Interactive session with demo on practical working of Gas Power based Engines	Introduction to adiabatic flame temperature
S-8	SLO-1	Solving Problems	Solving Problems	Solving Problems	Solving Problems	Solving Problems
	SLO-2	Solving Problems	Solving Problems	Solving Problems	Solving Problems	Solving Problems
S-9	SLO-1	Chapter Doubt clarification.	Chapter Doubt clarification.	Chapter Doubt clarification.	Chapter Doubt clarification.	Chapter Doubt clarification.
	SLO-2	Chapter Doubt clarification.	Chapter Doubt clarification.	Chapter Doubt clarification.	Chapter Doubt clarification.	Chapter Doubt clarification.

Learning Resources	1. Nag, P. K, Engineering Thermodynamics, 6th ed., Tata McGraw Hill, 2017 2. Rathakrishnan. E, Fundamentals of Engineering Thermodynamics, Prentice–Hall, India, 2005 3. Holman, J. P., Thermodynamics, 4th ed., Tata McGraw Hill, 2015 4. Rayner Joel, Basic Engineering Thermodynamics, 5th ed., Addison Wesley, 2016	5. Michael Moran, J., Howard Shapiro, N., Fundamentals of Engineering Thermodynamics, 4th ed., John Wiley & Sons, 2010 6. Yunus A. Cengel, Michael A. Boles, Thermodynamics an engineering approach, 7th ed., McGraw Hill, 2011

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Vinay Kumar Gupta, National Physical Laboratory, guptavinay@nplindia.org	1. Prof. D.P. Mishra, IIT Kanpur, mishra@ iitk.ac.in.	1. Dr. R. Vasudevan, SRMIST
2. Dr. S. Raja, National Aerospace Laboratories, Bangalore, raja@nal.res.in	2. Prof. Prasanta Kumar Das, IIT Kharagpur, pkd@mech.iitkgp.ernet.in.	2. Dr. T. Selvakumaran, SRMIST

Course Code	18ASC104J	Course Name	AIRCRAFT MATERIALS AND PRODUCTION TECHNIQUES	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	*Identify materials*
CLR-2 :	*Utilize the mechanical behavior of materials*
CLR-3 :	*Utilize the existing production technologies*
CLR-4 :	*Identifying the selection of materials*
CLR-5 :	*Identify material's Application*
CLR-6 :	*Utilize the experience of machining Techniques for real-time applicaions*

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1	Learning 2	Learning 3	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12	PLO 13	PLO 14	PLO 15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Identify materials and it properties*	2	80	70	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*Analyze the application of materials in different aircraft components*	2	85	75	H	H	-	-	H	-	-	-	-	-	-	-	-	-	-
CLO-3 :	*Identify different treatments to strengthen materials*	2	75	70	H	-	H	H	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*Identify different casting techniques*	2	85	80	H	H	-	-	H	-	-	-	-	-	-	-	-	-	-
CLO-5 :	*Analyze machining techniques*	2	85	75	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	*Analyze forming Techniques*	2	80	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Introduction to materials, mechanical properties*	*Heat Treatment*	*Casting Introduction*	*Mechanical working of Materials*	*Machining Process*
	SLO-2	*Fixed-wing aircraft structures*	*Purpose of Heat Treatment*	*Basic Terms*	*Introduction to mechanical Working*	*Introduction to Machines*
S-2	SLO-1	*Classification of aircraft materials*	*Principles of Heat Treatment*	*Casting Procedure*	*Hot Working*	*Lathe*
	SLO-2	*Materials used for aircraft components*	*Stages of Heat Treatment*	*Casting Nomenclature*	*Cold Working*	*Lathe Components, tools*
S-3	SLO-1	*Helicopter structures*	*Stages of Heat Treatment, Description*	*Sand Casting*	*Hot Working- Forging*	*Working of Lathe*
	SLO-2	*Space shuttle structures*	*Types of Heat treatment*	*Making of Sand Casting, Gating and risering System*	*Forging Types, Forging Defects*	*Operations in Lathe, tools*
S 4-5	SLO-1 SLO-2	*Lab 1: Step Turning*	*Lab 4: Drilling and Boring*	*Lab 7 Surface Grinding*	*Lab 10: Spur Gear Milling*	*Lab 13: Thread Cutting*
S-6	SLO-1	*Materials used in jet engines*	*Heat treatment of carbon steel*	*Special Casting Process*	*Rolling, Types of Rolling, Rolling Mills*	*Drilling Machine, Types of Drilling machine*
	SLO-2	*Light weight material for MAV/UAV.*	*Procedures of Heat treatment of carbon steel*	*Special casting process*	*Rolling Defects*	*Operations, Tools used in Drilling Machine*
S-7	SLO-1	*Super alloys.*	*Heat treatment of - aluminum alloys,*	*Expandable Mold Casting*	*Drawing*	*Shaper Machine*
	SLO-2	*Application of Composite materials*	*Procedures of Heat treatment of - aluminum alloys,*	*Shell Mold Casting*	*Drawing Types*	*Operations*
S-8	SLO-1	*Introduction to smart materials,*	*Heat treatment of titanium alloys.*	*Investment Casting*	*Extrusion*	*Quick return Mechanism*

	SLO-2	Shape memory alloys	Procedures of Heat treatment of titanium alloys	Investment Casting Process	Extrusion Types	Mechanism Detail
S 9-10	SLO-1	Lab 2: Taper Turning	Lab 5: Shaper	Lab 8 Cylindrical Grinding	Lab 11:Helical Gear Milling	Lab 14: Slotting
	SLO-2					
S-11	SLO-1	Advanced structure ceramic	Heat treatment of Magnesium alloys.	Permanent Mold Casting, Die Casting, Centrifugal Casting, Casting Defects	Sheet Metal Operations, Shearing Operations	Slotter machine, mechanisms, Grinding Machines
	SLO-2	intermetallics, Ni and Ti aluminide	Procedures of Heat treatment of Magnesium alloys	Casting Defects	Types of Shearing Dies	Cutting Tools in Grinding Machines
S-12	SLO-1	Introduction to FRP,	Case Hardening	Welding Introduction	Forming Operations	Operations in Grinding Machines
	SLO-2	Glass and Carbon Composites	Procedures of Case Hardening	Gas Welding, Arc Welding	Forming Operations	Types of Grinding Machines
S-13	SLO-1	Aerospace Applications – Plastics and Rubber.	Stress reliving Procedures	Laser Beam Welding	Cutting Tools in sheet metal Process	Milling
	SLO-2	Emerging trends in Aerospace materials,	Protective Treatments	Electron Beam Welding, Electric Resistance Welding	Striking Tools in Sheet Metals, Riveting	Milling Operations, Types of Milling Machines
S 14-15	SLO-1	Lab 3: Taper boring	Lab 6: Drilling, Reaming & Tapping	Lab 9: Grooving and Knurling	Lab 12: External keyway cutting	Lab 15:Gear hobbing
	SLO-2					

Learning Resources	1. Adrian P. Mouritz, Introduction to aerospace materials, Woodhead Publishing Limited, 2012 2. Dieter, G. E., Mechanical Metallurgy, McGraw Hill, Singapore, 2001 3. Keshu S.C, Ganapathy K.K, Aircraft production technique, Interline Publishing House, Bangalore 1993 4. Dr. P C Sharma, A Text book of Production Technology, 8th ed., S. CHAND and company Pvt. Ltd. 2014

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

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2. Dr. S. Raja, National Aerospace Laboratories, Bangalore, raja@nal.res.in	2. Dr. Ramesh Babu, N , nrbabu@iitm.ac.in	2. Mr. K B Ravichandra kumar, SRMIST

Course Code	18ASC105T	Course Name	AIRCRAFT SYSTEMS AND INSTRUMENTS	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Identify the type of control system and its components used in aircraft.*
CLR-2 :	*Layout the components and accessories of hydraulic & Pneumatic system.*
CLR-3 :	*Identify the type of powerplant and various system operations in aircraft engines*
CLR-4 :	*Demonstrate the cabin environmental control system, oxygen system and other auxiliary system of an airplane.*
CLR-5 :	*Identify the various aircraft instruments and their functions.*
CLR-6 :	*Utilize the knowledge acquired for design, development & maintenance of aircraft & aero engine systems.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	Program Learning Outcomes (PLO) 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1 :	*Understand the operation of various control system in an airplane*	2	80	70	H	-	L	L	L	-	-	-	-	-	-	L	L	M	M
CLO-2 :	*Acquire knowledge on hydraulic and pneumatic system of modern jet airliner.*	2	80	70	H	-	M	L	M	-	-	-	-	-	-	-	M	M	M
CLO-3 :	*Learn the working of various systems of piston and gas turbine engine*	2	80	70	H	-	L	L	M	-	-	-	-	-	-	L	M	M	M
CLO-4 :	*Appreciate the need and functions of Cabin Environmental Systems and auxiliary systems of aircraft.*	2	80	70	H	-	L	L	L	-	M	M	-	-	-	L	M	M	M
CLO-5 :	*Gain knowledge on principle and operation of various aircraft instruments.*	2	80	70	H	L	L	L	M	-	-	-	-	M	-	L	H	H	M
CLO-6 :	*Acquire comprehensive knowledge of aircraft systems, engine systems and its instrumentation.*	2	80	70	H	L	L	L	M	-	M	M	-	M	-	L	M	M	M

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Need for Control Systems*	*Introduction to Hydraulic Systems*	*Introduction to Aircraft Engines*	*Introduction to Cabin Environmental Control Systems*	*Introduction to Aircraft Flight Instruments*
	SLO-2	*Conventional Flight Controls.*	*Applications & Advantages*	*Types, Abnormal Combustion*	*Need for Aircraft Pressurization System*	*Types*
S-2	SLO-1	*Components of Conventional Flight Control System and their functions*	*Selection & Classification of Hydraulic Fluids*	*Introduction to Aircraft Fuel System*	*Principle of Air Cycle Cooling System*	*Principle of Air Data Instruments*
	SLO-2	*Push Pull rod System*	*Open Centre & Closed Centre System*	*Types of Fuel & Fuel System Components*	*Operation & Advantages*	*Operation of Altimeter*
S-3	SLO-1	*Cable Pulley System*	*Components of Hydraulic System and its functions*	*Gravity Feed Fuel System*	*Principle of Vapour Cycle Cooling System*	*Operation of Air Speed Indicator*
	SLO-2	*Disadvantages of Mechanical Control System.*	*Automatic Operating Control Valves*	*Pressure Feed Fuel System*	*Its Operation & Advantages*	*Operation of Vertical Speed Indicator*
S-4	SLO-1	*Challenges in Power Assisted Flight Control System*	*Study of Typical Hydraulic System for Modern Jet Airliner*	*Need for Lubrication System*	*Need for Cabin Heating System*	*Principle of Gyroscopic Instruments*
	SLO-2	*Q – Feel System*	*Operation and its Advantages*	*Functions and Characteristics of Lubricating Oil.*	*Types & Operation*	*Operation of Attitude Indicator*
S-5	SLO-1	*Servo Tabs*	*Aircraft Brake System*	*Types of Lubrication System, Wet Sump System*	*Need for Aircraft Oxygen System*	*Operation of Turn Coordinator*
	SLO-2	*Fully Powered Flight Control System for heavy aircraft*	*Types and Applications*	*Dry Sump System and their Advantages*	*Types & Advantages*	*Operation of Heading Indicator*

S-6	SLO-1	*Fly by Wire System (FBW)*	*Introduction to Pneumatic Systems*	*Need For Ignition System*	*Components of Oxygen System*	*Principle & Operation of Engine Instruments – Tachometer & EGT*
	SLO-2	*Operation of FBW & its Advantages*	*Applications & Advantages*	*Types of Ignition Systems*	*Its Operation*	*Principle & Operation of EPR, CHT & Manifold Pressure Gauge*
S-7	SLO-1	*Digital Fly by Wire System (DFBW)*	*Study of Typical Pneumatic System for Modern Airliner*	*Magneto Ignition System & its Operation*	*Introduction to Fire Detection Systems*	*Principle & Operation of Electronic Instruments – EADI & EHSI*
	SLO-2	*Operation of DFBW & its Advantages*	*Operation and its Advantages*	*Components of Ignition System of Gas Turbine Engine*	*Requirements for Fire Detection System*	*Principle & Operation of Electronic Systems Monitor Displays*
S-8	SLO-1	*Need for Automatic Flight Control Systems*	*Introduction to Landing Gear System*	*Need for Starting System*	*Types*	*Principle & Operation of EICAS*
	SLO-2	*Operation of Autopilot System*	*Classification of Landing Gear System*	*Types of starters*	*Principle and Operation*	*Need for Instrument Landing System (ILS)*
S-9	SLO-1	*Auto Throttle System (ATS)*	*Components of Landing Gear System*	*Pneumatic Starting System for Modern airliner*	*Need for Anti-Icing & De-Icing System*	*Components of ILS and their functions*
	SLO-2	*Advantages of ATS*	*Applications*	*Advantages of Pneumatic Starting System*	*Types and Applications.*	*Advantages*

Learning Resources	1. *Ian Moir, Allan Seabridge, Aircraft Systems – Mechanical, Electrical and Avionics subsystems integration, 3rd ed., Professional Engineering Publishing Limited, 2008* 2. *E.H.J.Pallet, Aircraft Instruments, 2nd ed.,Pearson Publishing Company, 2009* 3. *Aviation Maintenance Technician Handbook – Airframe, Vol.2, U.S.Dept. of Transportation, Federal Aviation Administration, Flight Standards Service, 2012*	4. *Aviation Maintenance Technician Handbook – Powerplant, Vol.1, 2, U.S.Dept. of Transportation, Federal Aviation Administration, Flight Standards Service, 2012* 5. *Michael J.Kroes, William A.Watkins ad Frank Delp, Aircraft Maintenance and Repair, 7th ed., Tata McGraw Hill, 2013* 6. *Irwin Treager, Aircraft Gas Turbine Engine Technology, 3rd ed., McGraw-Hill, 1997* 7. *The Jet Engine, 5th ed., Rolls Royce, Wiley Publication, 2005*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Wg.Cdr K.Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com	*1. Dr. A. P. Haran, Park College of Engineering & Technology, ap_haran@rediffmail.com*	*1. Dr. S. Sivakumar, SRMIST*
2. Dr. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	*2. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	*2. Mr. G. Mahendra Perumal, SRMIST*

Course Code	18ASC201J	Course Name	APPLIED SOLID MECHANICS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18ASC101T	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Identify the stresses generated and structural changes in different bar materials subjected to different loads
CLR-2 :	Identify the variation of shear force, bending moments and bending stress in various beams subjected to different loads
CLR-3 :	Know the variation of curvature of beams subjected to loads based on which the slope, deflection calculations be made
CLR-4 :	Identify the advantages and disadvantages of using solid and hallow shafts, different springs for different loads
CLR-5 :	Know the buckling characteristics of column for various end conditions and stresses generated in thin and thick cylinders
CLR-6 :	Know the behavior of different structural materials for different types of loading

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	Differentiate a ductile material and a brittle material after performing a tension test	2	80	70	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Analyze the shear force and bending diagrams in cantilever and simply supported beams	2	80	75	H	H	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Make calculations for the design of a beam based on the bending stress and desired deflection	2	75	70	H	H	H	H	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Design the shaft for a particular torque transmission and springs for energy absorption	2	80	75	H	H	H	H	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Find the planes of principal stresses in a stressed model and hoop stress, longitudinal stress in thin walled pressure vessel	2	85	75	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Calculate the various stresses generated in a particular element subjected to different loading	2	80	70	H	H	H	H	-	-	-	-	-	-	-	-	-	-	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Concept of stress and strain in a bar element	Hardness and Strength	Relation between deflection, slope, radius of curvature	Theory of pure torsion	Stresses on inclined planes
	SLO-2	Hooke's law, Poisson's ratio, Elastic young's modulus	Ductility and brittleness	Shear force and bending moment Derivation explanation for different loads	Explain shear stress variation in a circular (solid and hollow)	Derivation explanation
S-2	SLO-1	True and Engineering stress strain curve for ductile material in tension, compression	Difference between static loading and dynamic loading	Find slope and deflection in a cantilever beam by double integration method	Apply torsion equation based on allowable shear stress	Mohr's circle derivation
	SLO-2	True and Engineering stress strain curve for a brittle material in tension	Impact loading	Problem solving	Apply torsion equation based on allowable angle of twist	Plane stress case
S-3	SLO-1	Concept of shear stress, shear strain and Rigidity modulus	Statically Determinate structure, examples	Find slope and deflection in a simply supported beam by double integration	Compare solid and hollow shafts for transmission of same torque	Mohr's circle construction
	SLO-2	Principle of complementary shear	Statically Indeterminate structure, examples	Problem solving	Applications explanation	Procedure to different kinds of load
S 4-5	SLO-1 SLO-2	Lab1: Tension test	Lab-4: Brinell Hardness Test and Vickers hardness test	Lab-7: Deflection test in a cantilever beam with a point loads	Lab-10: Torsion test on a circular rod using digital torsion testing machine	Lab 13: Charpy Impact test and Izod impact test
S-6	SLO-1	Biaxial and triaxial state of stress and volumetric strain	Beam, types of beams, types of load	Find slope and deflection in a simply supported beam by Macaulay's method	Explain shear stress variation in closed coil helical sprigs	Concept of pure shear, relation between Young's, Shear and bulk modulus
	SLO-2	Problem solving	Procedure of solving a beam	Problem solving	Applications	Derivation explanation
S-7	SLO-1	Analysis of prismatic bar subjected to	Shear force and bending moment diagram	Moment Area Theorem-I	Explain shear stress variation in open coil	Numerical solving

		single load	and their sign convention		helical springs	
	SLO-2	Analysis of prismatic bar subjected to varying loads	Shear force and bending moment diagram for a cantilever beam subjected to point load and UDL	Application to cantilever and simply supported beam	Numerical explanation	Numerical solving
S-8	SLO-1	Analysis of non-prismatic bar subjected to single load	Shear force and bending moment diagram for a simply supported beam subjected to point load	Moment Area Theorem-II	Stiffness of closed coil helical spring	Fatigue load-Explanation
	SLO-2	Analysis of non-prismatic bar subjected to varying loads	Shear force, bending moment diagram for a simply supported beam subjected to UDL	Application to cantilever and simply supported beams	Stiffness of open coil helical spring	S-N curve for various materials
S 9-10	SLO-1 SLO-2	Lab-2: Compression test	Lab-5: Repeat	Lab-8: Deflection test: Simply supported beam	Lab-11: Tension test on a closed coil helical spring	Lab-14: Determine endurance limit of the given material by performing a fatigue test.
S-11	SLO-1	Analysis of composite bars	Shear force and bending moment diagram for a overhanging beam	Principle of superposition	Shaft subjected to combined bending and torsion	Thin walled pressure vessel subjected to internal pressure
	SLO-2	Numerical solving	Point of contraflexure	Application	Derivation	Hoop stress explanation
S-12	SLO-1	Thermal stresses-Support Yield	Explanation of bending stress variation in a beam subjected to pure bending	Maxwell reciprocal theorem	Strain energy due bending	Thin walled cylindrical pressure vessel
	SLO-2	Numerical Solving	Application	Application	Derivation	Longitudinal stress explanation
S-13	SLO-1	Thermal stresses-composite bars	Explain shear stress variation in a beam of symmetrical and unsymmetrical cross sections subjected to bending	Explain shear force diagram of an aircraft wing	Strain energy due torsion	Thick cylinder
	SLO-2	Problem solving	Application	Explain bending moment diagram of an aircraft wing	Derivation	Lame's theory
S 14-15	SLO-1 SLO-2	Lab-3: Study of magnified images obtained using Inverted Metallurgical Microscope on a specimen.	Lab-6: Rockwell Hardness Test	Lab-9:Repeat	Lab-12: Compression test on an open coil helical spring	Lab-15 :Repeat

Learning Resources	1. Ferdinand P.Beer, Rusell Johnston, John T.Dewolf, Mechanics of Materials, SI Metric, 3rd ed., Tata McGraw-Hill Education, 2011 2. Egor P. Popov., Engineering Mechanics of Solids, 2nd ed., Prentice Hall of India, 2009	3. James M. Gere, Mechanics of Materials, 8th ed.,Brooks/Cole, USA, 2013 4. Shigley, J. E., Applied Mechanics of Materials, International Student Edition, McGraw Hill, 2000 5. V. Feodosyev. Strength of Materials, MIR Publishers, Moscow 1968

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember / Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply / Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate / Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

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2. Wg.Cdr K.Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com	*2. Dr. A. P. Haran, Park College of Engineering & Technology, ap_haran@rediffmail.com*	*2. Mr. K B Ravichandra kumar, SRMIST*

Course Code	18ASC202J	Course Name	INCOMPRESSIBLE AERODYNAMICS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18ASC102J	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Identify and utilize the lift generating devices
CLR-2 :	Evaluate the forces and moments acting on aero foils and wings under ideal flow conditions.
CLR-3 :	Evaluate and optimize the aerofoil characteristics
CLR-4 :	Evaluate and optimize the wing characteristics.
CLR-5 :	Evaluate and optimize the propeller characteristics.
CLR-6 :	Evaluate and optimize the aerodynamic interaction effects between different components of aircraft

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Understand the lift generation and lift generating devices	1	80	75	M	M	M	H	M	-	-	-	-	-	-	M	-	H	-
CLO-2 :	Analyze the forces and moments acting on aero foils and wings under ideal flow conditions.	2	80	75	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-
CLO-3 :	Analyze the aerofoil characteristics.	3	70	60	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-
CLO-4 :	Analyze the wing characteristics.	3	70	60	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-
CLO-5 :	Analyze the propeller characteristics.	3	70	60	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-
CLO-6 :	Analyze the aerodynamic interaction effects between different components of aircraft	2	70	65	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	Introduction to aerodynamics	Center of pressure	High lift devices	torque grading and efficiency equation	Influence of taper and twist applied to wings
	SLO-2	Introduction to the mathematical model of flow	Aerodynamic center	Thin airfoil theory-Flapped airfoil - circulation equation	Combined blade element and momentum theories velocity comparison	effect of sweep back and delta wings
S-2	SLO-1	Airfoil geometry	Numerical problems on Center of pressure	Thin airfoil theory-Flapped airfoil - coefficient of lift and moment	Comparison of thrust and torque equation	Fundamentals of potential flows
	SLO-2	Airfoil nomenclature	Numerical problems on Aerodynamic center	Geometry of the propeller	Axial flow factor equation	Indirect and direct methods of mathematical model of flow
S-3	SLO-1	Wing geometry parameters	Numerical problems on Center of pressure and Aerodynamic center	Forces acting on Propeller	Angular flow factor equation	Basic equations of potential flow
	SLO-2	Application of wing geometry parameters	Experimental characteristics of airfoil	Types of Propeller	The Biot-savart law	Introduction to panel methods
S 4-5	SLO-1 SLO-2	Lab 1: Introduction to subsonic wind tunnel	Lab 4: Study of flow over streamlined body by laser beam assisted smoke visualization technique	Lab 7: Study of flow over a tapered finite wing with wingtip by laser beam assisted flow visualization technique	Lab 10: Pressure distribution and Estimation of forces acting over a rough cylinder	Lab 13: Estimation of forces acting over a streamlined body using force balance method
S-6	SLO-1	Vortex motions, vortex filament, vortex sheet	Thin airfoil theory assumptions and limitations.	Propeller arrangements	Application of Biot-savart law	Source panel method
	SLO-2	Vortex types, Starting vortex, trailing edge vortex	Fundamental equation of thin airfoil theory	Axial momentum theory assumptions and limitations.	Introduction of Prandtl’s lifting line theory	Application of Source panel method

S-7	SLO-1	kutta's and kelvins theorem	Thin airfoil theory- symmetrical airfoil – circulation equation	Pressure and velocity distribution across the propeller control volume	Governing equations of Prandtl's lifting line theory	Vortex panel method
	SLO-2	Kutta – Joukowski theorem	Thin airfoil theory- symmetrical airfoil – coefficient of lift and moment	Propeller thrust equation	Applications of Prandtl's lifting line theory	Application of Vortex panel method
S-8	SLO-1	Lift generation	Thin airfoil theory- symmetrical airfoil – location of forces	Propeller power equation	Prandtl theory- Elliptical lift Distribution – circulation equation	Wing- fuselage interference
	SLO-2	bound and horseshoe vortex	Numerical problems on thin airfoil theory	efficiency equation and comparison	Prandtl theory- Elliptical lift Distribution – downwash and induced angle	Wing-engine interference
S 9-10	SLO-1	Lab 2: Wind tunnel measurement techniques	Lab 5: Study of Magnus effect using rotating cylinder by laser beam assisted smoke visualization technique.	Lab 8: Calibration of subsonic wind tunnel	Lab 11: Pressure distribution and Estimation of forces acting over a sphere model	Lab 14: Estimation of pressure distribution acting over a symmetrical / unsymmetrical airfoil for different angle of attack
	SLO-2					
S-11	SLO-1	Aerodynamic forces	Thin airfoil theory- unsymmetrical airfoil- circulation equation	Numerical problems on Axial momentum theory	Prandtl theory- Elliptical lift Distribution- coefficient of lift and induced drag	Wing-landing gear interference
	SLO-2	Aerodynamic moments	Thin airfoil theory- unsymmetrical airfoil – verification of circulation equation	Numerical problems on Axial momentum theory	Fundamentals of Prandtl theory- General lift Distribution	Wing – propeller interference
S-12	SLO-1	Types of drag	Thin airfoil theory- unsymmetrical airfoil – coefficient of lift	Numerical problems on Axial momentum theory	Prandtl theory- General lift Distribution- circulation equation	Wing –tail interference
	SLO-2	Numerical problems on Aerodynamic forces	Thin airfoil theory- unsymmetrical airfoil – coefficient of moment and location of forces	fundamentals of blade-element theory	Prandtl theory- General lift Distribution- coefficient of lift and induced drag	interference flow over an airplane as a whole
S-13	SLO-1	Numerical problems on Aerodynamic forces and moments	Numerical problems on thin airfoil theory	Basic equation of thrust and torque grading	Lift slope relation	Passive Laminar flow control methods
	SLO-2	Numerical problems on Aerodynamic forces and moments	Numerical problems on thin airfoil theory	thrust grading equation	Numerical problems on Lift slope relation	Active Laminar flow control methods
S 14-15	SLO-1	Lab 3: Study of flow over bluff body by laser beam assisted smoke visualization technique	Lab 6: Study of flow over a tapered finite wing without wingtip by laser beam assisted flow visualization technique	Lab 9: Pressure distribution and Estimation of forces acting over a smooth cylinder	Lab 12: Estimation of forces acting over a bluff body using force balance method	Lab 15: Estimation of forces acting over a symmetrical / unsymmetrical airfoil for different angle of attack
	SLO-2					

Learning Resources	1. Houghton, E, L., Carruthers, N, B., Aerodynamics for Engineering Students, 6th ed., Edward Arnold Publishers Ltd., London, 2012 2. Anderson, J,D., Fundamentals of Aerodynamics,6th ed., McGraw Hill, 2016	3. Clancy, L, J., Aerodynamics, Pitman, 1986 4. Milne, L.H., Thomson, Theoretical Aerodynamics, Dover, 1985

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Wg.Cdr K.Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com	*2. Dr. P. K Dash, Nitte Meenakshi Institute of Technology, Bangalore, drpdash@gmail.com*	*2. Mr. K B Ravichandra kumar, SRMIST*

Course Code	18ASC203T	Course Name	AIR BREATHING PROPULSION	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Identify the working principles of gas turbine propulsion systems*
CLR-2 :	*Design of inlets, combustion chambers, nozzles used in Air breathing engines*
CLR-3 :	*Design of compressors in gas turbine propulsion systems*
CLR-4 :	*Design of turbines in gas turbine propulsion systems*
CLR-5 :	*Understand the principle of operation of Pulse jet, RAMJET and SCRAMJET engines*
CLR-6 :	*Understand the working principles of gas turbine propulsion systems*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1 Level of Thinking (Bloom)	2 Expected Proficiency (%)	3 Expected Attainment (%)	PLO 1 Engineering Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design, Research	5 Modern Tool Usage	6 Society & Culture	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1 :	*Analyze the performance and component efficiencies of gas turbine propulsion systems*	2	80	70	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	*Analyze inlets, combustion chambers, nozzles used in Air breathing engines*	2	85	75	H	H	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	*Analyze the compressors in gas turbine propulsion systems*	2	75	70	H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	*Analyze the turbines in gas turbine propulsion systems*	2	85	80	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	*Analyze the performance of Pulse Jet, RAMJET and SCRAMJET engines*	2	85	75	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	*Analyze the performance and component efficiencies of gas turbine propulsion systems*	2	80	70	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Introduction to Air breathing engines*	*Inlets*	*Compressor*	*Turbine*	*Pulse Jet Engine-Operating Principle*
	SLO-2	*Ideal and actual Brayton cycle*	*Classification of Inlets*	*Classification of compressors*	*Classification of turbines*	*RAMJET Engine*
S-2	SLO-1	*Turbojet Engine*	*Subsonic Inlets*	*Axial flow compressor*	*Axial flow turbine stage*	*Working of RAMJET*
	SLO-2	*Numerical Problems on turbojet engine*	*Supersonic Inlets*	*Work and compression ratio*	*Velocity triangles and Power output*	*Working of RAMJET*
S-3	SLO-1	*High bypass turbofan Engine*	*Modes of Inlet operation*	*Degree of reaction*	*Blade Element theory*	*RAMJET with afterburner*
	SLO-2	*Low bypass turbofan engine*	*Starting problems and Shock swallowing methods*	*Characteristic performance of a single stage axial compressor*	*Blade Element theory*	*RAMJET with afterburner*
S-4	SLO-1	*Numerical Problems on turbofan engine*	*Numerical Problems on Inlets*	*Characteristic performance of a multistage axial compressor*	*Free vortex theory*	*RAMJET performance*
	SLO-2	*Numerical Problems on turbofan engine*	*Numerical Problems on Inlets*	*Cascading of axial compressor-Compressor efficiency*	*Free vortex theory*	*RAMJET performance*
S-5	SLO-1	*Turboshaft engine*	*Gas turbine combustion chamber*	*Numerical Problems on Single stage Axial flow compressor*	*Limiting Factors of gas turbine design*	*Numerical Problems on RAMJET*
	SLO-2	*Turboprop engine*	*Types of combustion chamber*	*Numerical Problems on Single stage Axial flow compressor*	*Limiting Factors of gas turbine design*	*Numerical Problems on RAMJET*
S-6	SLO-1	*Numerical Problems on turboprop engine*	*Fuel injector- Flame Tube cooling*	*Numerical Problems on multi stage Axial flow compressor*	*Turbine performance*	*SCRAMJET Engine*
	SLO-2	*Numerical Problems on turboprop engine*	*Flame Stabilization-Flame holders*	*Numerical Problems on multi stage Axial*	*Turbine blade cooling*	*Working principle of SCRAMJET Engine*

				flow compressor		
S-7	SLO-1	Typical engine performance	Nozzle	Centrifugal compressor	Turbine blade cooling methods	Problems faced in supersonic combustion
	SLO-2	Typical engine performance	Classification of nozzles	Working Principle of a centrifugal compressor	Turbine and compressor matching	Problems faced in supersonic combustion
S-8	SLO-1	Methods of thrust augmentation	Numerical Problems on Nozzles.	Work and compression ratio	Numerical Problems on Axial flow turbine	Numerical Problems on SCRAMJET
	SLO-2	Methods of thrust augmentation	Numerical Problems on Nozzles.	Work and compression ratio	Numerical Problems on Axial flow turbine	Numerical Problems on SCRAMJET
S-9	SLO-1	Introduction to Air breathing engines	Inlets	Compressor	Turbine	Pulse Jet Engine-Operating Principle
	SLO-2	Ideal and actual Brayton cycle	Classification of Inlets	Classification of compressors	Classification of turbines	RAMJET Engine

Learning Resources	1. Hill, P. G., Peterson, C. R., Mechanics and Thermodynamics of Propulsion, 2nd ed., Addison-Wesley Publishing Company, 1992. 2. Cohen. H. Rogers. G.F.C., Saravanamuttoo. H.I.H., Gas turbine theory. 4th ed., Pearson education 3. V.Ganesan., Gas Turbines, 3rd ed., Tata McGraw-Hill Education, 2010	4. Rolls-Royce , Jet Engine Manual, 3rd edition, 1983 5. Oats, G.C., Aerothermodynamics of Aircraft Engine Components, AIAA Education Series,1985 6. Mattingly, J.D., Heiser, W.H., Pratt,D.T., Aircraft Engine Design, AIAA Education Series, 2002

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	1. Dr. P. K Dash, Nitte Meenakshi Institute of Technology, Bangalore, drpdash@gmail.com	1. Mr. G. Saravanan, SRMIST
2. Wg.Cdr K.Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com	2. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu	2. Mr. G. Mahendra Perumal, SRMIST

ACADEMIC CURRICULA

Professional Core Courses

AEROSPACE ENGINEERING

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18ASC301J	Course Name	COMPRESSIBLE AERODYNAMICS	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18ASC202J*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*		Data Book / Codes/Standards	*Gas tables*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	*Identify the different wave types and wave propagation*																		
CLR-2 :	*Evaluate the change in properties across shock waves and optimize the supersonic vehicle design*																		
CLR-3 :	*Evaluate the change in properties across expansion waves*																		
CLR-4 :	*Evaluate and optimize the nozzle flow characteristics.*																		
CLR-5 :	*Design and Evaluate the duct flow with heat transfer and frictional effect.*																		
CLR-6 :	*Design and optimize the supersonic nozzle*																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	*Understand the properties of different waves in supersonic flow*	*1*	*90*	*80*	*H*	*M*	*M*	*M*	*M*	-	-	-	-	-	-	*M*	-	*H*	-
CLO-2 :	*Analyze the properties of shock wave*	*2*	*80*	*75*	*H*	*H*	*H*	*H*	*H*	-	-	-	-	-	-	*H*	-	*H*	-
CLO-3 :	*Analyze the properties of expansion wave*	*3*	*80*	*75*	*H*	*H*	*H*	*H*	*H*	-	-	-	-	-	-	*H*	-	*H*	-
CLO-4 :	*Analyze the flow through nozzle*	*3*	*70*	*60*	*H*	*H*	*H*	*H*	*H*	-	-	-	-	-	-	*H*	-	*H*	-
CLO-5 :	*Analyze the heat transfer and frictional effect in flow*	*3*	*80*	*75*	*H*	*H*	*H*	*H*	*H*	-	-	-	-	-	-	*H*	-	*H*	-
CLO-6 :	*Analyze the compressibility effects and design the supersonic nozzle*	*2*	*70*	*60*	*H*	*H*	*H*	*H*	*H*	-	-	-	-	-	-	*H*	-	*H*	-

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Introduction to compressible flow*	*Normal shock wave properties – Mach number relation*	*Multiple shock system*	*Numerical problems on Nozzle flow relations*	*Fanno curve*
	SLO-2	*Basic thermodynamic concepts*	*Normal shock wave properties – density relation*	*Numerical problems on multiple shock systems*	*Numerical problems on Nozzle flow relations*	*Numerical problems on Fanno flow*
S-2	SLO-1	*Basic thermodynamic equations*	*Normal shock wave properties – pressure relation*	*The propagating shock wave*	*Numerical problems on Nozzle flow relations*	*Numerical problems on Fanno flow*
	SLO-2	*Momentum and Energy equations for compressible fluid flow*	*Normal shock wave properties – temperature relation*	*Numerical problems on propagating shock wave*	*Rayleigh flow equations – static properties*	*Numerical problems on Fanno flow*
S-3	SLO-1	*Wave propagation*	*Normal shock wave properties – entropy change*	*Governing equation of Prandtl-meyer expansion waves*	*Rayleigh flow equations – stagnation properties*	*Velocity potential equation for compressible flow*
	SLO-2	*Shock formation*	*Hugoniot equation*	*Expression of Prandtl –meyer function*	*variation of flow properties for subsonic flow*	*Small perturbation theory*
S 4-5	SLO-1 SLO-2	*Lab 1: Study of various types of Supersonic wind tunnel.*	*Lab 4: Calibration of supersonic wind tunnel*	*Lab 7: Visualization of shock wave pattern on ramp model using Schlieren flow visualization technique*	*Lab 10: Visualization of shock wave pattern on Diamond Airfoil using Schlieren flow visualization technique*	*Lab 13: Investigation of intersection of right and left running shock waves for various deflection angles using Schlieren flow visualization*
S-6	SLO-1	*types of waves*	*Numerical problems on normal shock*	*Numerical problems on expansion waves*	*variation of flow properties for supersonic flow*	*Small perturbation theory*
	SLO-2	*Speed of sound derivation*	*Numerical problems on normal shock*	*Numerical problems on expansion waves*	*Critical reference states*	*Linearized pressure coefficient*

Duration (hour)		15	15	15	15	15
S-7	SLO-1	*Change in entropy relation*	*Numerical problems on normal shock*	*Shock Expansion theory – flat plate*	*Rayleigh curve*	*Linearized pressure coefficient*
	SLO-2	*Numerical problems on thermodynamic concepts*	*Oblique shock properties*	*Numerical problems on shock expansion theory*	*Numerical problems on Rayleigh flow*	*Prandtl-Glauert compressibility correction*
S-8	SLO-1	*Isentropic relations*	*Θ-β-M relation and graph*	*Shock Expansion theory – Diamond airfoil*	*Numerical problems on Rayleigh flow*	*Supersonic linearized theory*
	SLO-2	*Numerical problems on isentropic relations*	*Supersonic flow over wedges and cones*	*Numerical problems on shock expansion theory*	*Numerical problems on Rayleigh flow*	*Application of Supersonic linearized theory*
S 9-10	SLO-1 SLO-2	*Lab 2: Study of various Supersonic flow visualization techniques and its applications.*	*Lab 5: Mach number distribution of different area ratio C-D nozzles*	*Lab 8: Visualization of shock wave pattern on wedge model using Schlieren flow visualization technique*	*Lab 11: Investigation of supersonic flow over different aircraft/ missile models using Schlieren flow visualization technique*	*Lab 14: Experimental study of supersonic jet*
S-11	SLO-1	*Isentropic relations – stagnation state*	*Shock polar*	*Nozzle flow relations: Area – velocity*	*Fanno flow- equations*	*Numerical problems on linearized theory*
	SLO-2	*Numerical problems on isentropic relations*	*Shock reflections*	*Supersonic nozzle and diffuser*	*Fanno flow- equations*	*Numerical problems on linearized theory*
S-12	SLO-1	*Isentropic relations – critical state*	*Shock interactions*	*Nozzle flow relations: Area – Mach number*	*variation of flow properties with duct length*	*Introduction to Method of characteristics*
	SLO-2	*Numerical problems on isentropic relations*	*Numerical problems on oblique shock*	*Nozzle flow relations: Maximum mass flow rate*	*variation of flow properties for subsonic flow*	*Method of characteristics*
S-13	SLO-1	*Characteristic Mach number*	*Numerical problems on oblique shock*	*Variation of Pressure and Mach number along the C-D nozzle*	*variation of flow properties for supersonic flow*	*Application of Method of characteristics*
	SLO-2	*Numerical problems on isentropic relations*	*Numerical problems on oblique shock reflections*	*Under expansion and over expansion nozzle*	*Critical reference states*	*Application of Method of characteristics*
S 14-15	SLO-1 SLO-2	*Lab 3: Study of SRM supersonic wind tunnel and its instrumentations.*	*Lab 6: Investigation of starting normal shock wave movement inside Convergent Divergent Nozzle.*	*Lab 9: Verification of "Three dimensional relieving effect".*	*Lab 12: Investigation of detached shock wave pattern using Schlieren flow visualization technique*	*Lab 15: Noise measurement in supersonic jet*

Learning Resources	1. *Rathakrishnan, E., "Gas Dynamics", Prentice Hall India Learning Private Limited, 6th edition, Delhi, India, 2016.* 2. *Anderson J. D., Jr., "Modern Compressible Flow with Historical Perspective," McGraw Hill Publishing Co., 3rd edition, 2017*	3. *Shapiro, A.H., "The Dynamics and Thermodynamics of Compressible Fluid Flow (Vol I and Vol II)", Ronald Press, 1953.* 4. *Zucker, R. D., Biblarz, O., "Fundamentals of Gas Dynamics", Wiley-Blackwell; Third edition (2019)* 5. *Yahya, S. M., "Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion", New Age International Publishers; Sixth edition (2018)*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr Manishankar C, Senior Scientist, CSIR - National Aerospace Laboratories Bangalore.	*1. Dr .Arun Kumar Perumal, Mechanical Eng, IIT Jammu, arun.perumal@iitjammu.ac.in*	*1. Mr. R. Mohamed Arif, SRMIST.*
		2. Dr. K. K. Bharadwaj, SRMIST.

Course Code	18ASC302T	Course Name	FLIGHT DYNAMICS - I	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*18ASC202J*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand the art of application of aerodynamics knowledge into an aircraft*
CLR-2 :	*Know the performance of different powerplants at different flight conditions*
CLR-3 :	*Know the various performance parameters of an airplane*
CLR-4 :	*Learn optimizing different performance parameters for maximizing range, endurance and fuel efficiency*
CLR-5 :	*Learn role of performance parameters in various maneuvers of the airplane*
CLR-6 :	*Learn experimental determination of various performance parameters of a real airplane by flight testing*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*
CLO-1 :	*Estimate and optimize drag polar of an aircraft*
CLO-2 :	*Select optimal powerplant for the required airplane with the desired performance*
CLO-3 :	*Indicate the different flight techniques for optimized steady and accelerated flight performance*
CLO-4 :	*Perform basic calibration of flight instrument data*
CLO-5 :	*Perform conceptual design of any type of airplane*
CLO-6 :	*Determine the drag polar of a real airplane with real flight testing*

	Learning			Program Learning Outcomes (PLO)														
	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1	*3*	*85*	*90*	*H*	*M*	*M*	*H*	*L*	*-*	*H*	*-*	*-*	*-*	*-*	*H*	*H*	*H*	*-*
CLO-2	*3*	*80*	*85*	*M*	*M*	*M*	*M*	*L*	*-*	*H*	*-*	*M*	*-*	*-*	*H*	*H*	*H*	*-*
CLO-3	*3*	*75*	*80*	*M*	*H*	*M*	*H*	*M*	*-*	*H*	*-*	*-*	*-*	*-*	*H*	*H*	*H*	*-*
CLO-4	*3*	*50*	*60*	*M*	*M*	*M*	*M*	*L*	*-*	*L*	*-*	*M*	*-*	*-*	*H*	*H*	*H*	*M*
CLO-5	*3*	*70*	*70*	*M*	*M*	*H*	*H*	*M*	*M*	*H*	*M*	*H*	*-*	*M*	*H*	*H*	*H*	*-*
CLO-6	*3*	*00*	*80*	*M*	*H*	*M*	*M*	*M*	*-*	*-*	*-*	*M*	*M*	*-*	*H*	*-*	*H*	*M*

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Forces and moments acting on a vehicle in flight*	*Thrust and propulsive efficiency of air breathing engine*	*Equation of motion for steady level flight*	*Range -Definition and conditions for maximum range for jet driven aircraft*	*Flight instruments- Air Data systems*
	SLO-2	*Coordinate systems*	*Thrust and propulsive efficiency of rocket engine*	*Conditions for maximum velocity in steady level flight*	*Range -Definition and conditions for maximum range for propeller driven aircraft*	*Altitude and speed definitions*
S-2	SLO-1	*Equations of motion of a rigid flight vehicle*	*Trade-off between thrust and propulsive efficiency*	*Conditions for minimum in steady level flight*	*Endurance – Definition and conditions for maximum endurance for jet driven airplane*	*Air speed indicator- construction and working*
	SLO-2	*Solving Problems*	*Solving Problems*	*Solving problems*	*Endurance – Definition and conditions for maximum endurance for propeller driven airplane*	*Air speed indicator- speed calibration*
S-3	SLO-1	*International Standard Atmosphere and various layers in ISA*	*TSFC and BSFC*	*Solving problems*	*Solving problems*	*Solving air speed calibration problems*
	SLO-2	*Derivation of hydrostatic equation*	*Variation of Thrust/Power and SFC with respect to velocity and altitude for reciprocating engine*	*Power required vs velocity – Graphical approach and analytical approach*	*Solving problems*	*Solving air speed calibration problems*
S-4	SLO-1	*Derivation of Pressure, Temperature and density in troposphere*	*The propeller – variation of propulsive efficiency with advance ratio*	*Power available and maximum velocity for propeller driven and jet driven aircraft*	*Accelerated flight- Level turn- Equations of motion*	*Altimeter- construction and working*
	SLO-2	*Solving Problems in Gradient layer*	*Constant speed propellers*	*Minimum velocity- Stall and high lift devices*	*Level turn- conditions for turn radius and turn rate*	*Altimeter- altitude corrections*

Duration (hour)		9	9	9	9	9
S-5	SLO-1	*Derivation of Pressure, Temperature and density in Stratosphere*	*Variation of Thrust/Power and SFC with respect to velocity and altitude for turbojet engine*	*Aerodynamic relations associated with maximum efficiency conditions*	*Level turn- constraints on load factor, Constraints on velocity,*	*Solving problems- altimeter*
	SLO-2	*Solving Problems in Iso thermal layer*	*Solving Problems*	*Solving problems*	*Level turn- calculation of minimum turn radius and minimum turn rate.*	*Rate of climb indicator – construction and working*
S-6	SLO-1	*Various types of drags acting on an airplane*	*Variation of Thrust/Power and SFC with respect to velocity and altitude for turbofan engine*	*Rate of climb- equation of motion*	*Solving problems*	*Mach meter- construction and working*
	SLO-2	*Methods to minimize various drags*	*Solving Problems*	*Rate of climb- Graphical approach and hodograph*	*Solving problems*	*Angle of attack indicator- construction and working*
S-7	SLO-1	*Interference Drag and methods to minimize it Drag polar of vehicles in subsonic speed*	*Variation of Thrust/Power and SFC with respect to velocity and altitude for turboprop engine*	*Analytical approach for maximum climb angle*	*Pull-up and pull-down maneuvers*	*Flight determination of drag polar- introduction*
	SLO-2	*Transonic Drag Divergence*	*Solving Problems*	*Analytical approach for maximum rate of climb*	*V-n diagram and its significance*	*Flight determination of drag polar- speed power method*
S-8	SLO-1	*Wave drag and methods to minimize it*	*Thrust available characteristics of different engines*	*Absolute ceiling and service ceiling*	*Takeoff performance – ground roll*	*Flight determination of drag polar- incremental drag method*
	SLO-2	*Solving Problems*	*Selection of Powerplant*	*Solving problems*	*Estimation of takeoff distance*	*Flight determination of drag polar- prop feathered sinks method*
S-9	SLO-1	*Drag polar of vehicles in supersonic speeds*	*Thrust required vs velocity- Graphical approach*	*Gliding flight- Equation of motion, glide hodograph*	*Landing performance – Estimation of landing distance*	*Flight determination of drag polar- incremental power method*
	SLO-2	*Drag polar of vehicles in hypersonic speeds*	*Thrust required vs velocity- Analytical approach*	*Minimum sink rate and minimum glide path angle conditions*	*Methods to minimise landing distance*	*Solving problems*

Learning Resources	1. *Perkins, C. D., and Hage, R, E., "Airplane Performance, Stability and Control," Wiley Toppan, 1974* 2. *John D. Anderson, "Aircraft Performance and Design", McGraw-Hill, 1999*	3. *Nelson, R.C., "Flight Stability and Automatic Control", McGraw Hill, 1989.* 4. *McCormik, B. W., "Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, 1995.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	*1. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	*1. Mr. M. Vignesh Kumar, SRMIST*
2.Wg.Cdr K.Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com	*2. Dr. P. K Dash, Nitte Meenakshi Institute of Technology, Bangalore, drpdash@gmail.com*	*2. Mr. K. Allwyn, SRMIST*

Course Code	18ASC303J	Course Name	ROCKET PROPULSION	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*18ASC203T*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace* Engineering		Data Book / Codes/Standards		*Gas Tables*

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Understand the basic principles of rocket propulsion system*
CLR-2 :	*Understand the basic performance parameters ofchemical propellants.*
CLR-3 :	*Design the Solid Propellant Rocket*
CLR-4 :	*Designthe Liquid Propellant Rocket*
CLR-5 :	*Understand the working of advanced rocket propulsion techniques*
CLR-6 :	*Understand Rocket propulsion system, design, advanced propulsion system and it's applications*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	*Design a multistage rocket and analyze its performance*	2	85	75	H	-	H	-	-	-	-	-	-	-	-	-	M	-	M
CLO-2 :	*Analyze the performance parameter and choose the chemical propellant*	2	85	75	H	H	H	-	-	-	-	-	-	-	-	-	-	M	-
CLO-3 :	*Analyze the Solid Propellant Rocket*	2	85	75	H	-	H	H	-	-	-	-	-	-	-	-	M	M	M
CLO-4 :	*Analyze the Liquid Propellant Rocket*	2	85	75	H	H	-	-	-	-	-	-	-	-	-	-	M	M	M
CLO-5 :	*Understand the working of advanced rocket propulsion techniques*	2	85	75	H	-	-	-	-	-	-	-	-	-	-	-	-	H	-
CLR-6 :	*Have a detailed knowledge of Rocket propulsion system, design, advanced propulsion system and it's applications*	2	85	75	H	H	H	H	-	-	-	-	-	-	-	-	M	M	M

Duration (hour)		15	15	15	15	15
S-1	SLO-1 SLO-2	*History and evolution of rockets*	*Introduction of chemical propellant*	*Introduction of Solid Propellant Rocket*	*Introduction of Liquid Propellant Rocket*	*Hybrid propellant rocket*
S-2	SLO-1	*Rocket working principle*	*Molecular mass*	*Classifications of Solid Propellant Rocket*	*Classifications of Liquid Propellant Rocket*	*Electrical rockets*
	SLO-2	*Classification of rockets*	*Specific Heat*	*Hardware components and its functions*	*Hardware components and its functions*	*Electro-thermal propulsion system*
S-3	SLO-1	*Rocket equation*	*specific heat ratio*	*Mechanism of burning*	*Propellant feed systems*	*Arc-jet thruster*
	SLO-2	*Numerical Problems on Rocket equation*	*Stoichiometric ratio*		*Pressure feed system*	*Resistojet thruster*
S 4-5	SLO-1 SLO-2	*Lab 1: Study of Piston Engines*	*Lab 4: Determination of convective heat transfer coefficient over a flat plate by forced convection*	*Lab 7: Performance test on a propeller*	*Lab 10: Burning rate measurement of solid propellant by using Window bomb setup*	*Lab 13: Hybrid Rocket motor fuel grain preparation*
S-6	SLO-1	*Mass ratio of rocket*	*mixture ratio and equivalence ratio*	*Ignition system*	*Turbo pump feed system*	*Electro-static propulsion system*
	SLO-2	*NumericalProblems on rocket parameters*	*Energy release during combustion*	*Igniter types*	*Numerical Problemson feed system*	*Electro-magnetic propulsion system*
S-7	SLO-1	*Rocket Nozzles and its Classifications*	*Heat of formation*	*Propellant grain*	*Injector*	*Ion thruster*
	SLO-2	*Nozzle Performance*	*Heat of combustion*	*configuration and applications of propellant grain*	*Types of injector*	*Hall Effect Thruster*
S-8	SLO-1	*Nozzle area ratio- Mass flow rate*	*Criterion for choice of propellant*	*Burn rate*	*NumericalProblems on injector*	*Magneto plasma dynamic thruster*
	SLO-2	*NumericalProblems on nozzle*	*Solid propellants*	*Factors influencing burn rates*		*Pulsed Plasma Thruster*
S 9-10	SLO-1 SLO-2	*Lab 2: Study of jet engines*	*Lab 5: Characteristic plots of a free jet through a non-circular orifice*	*Lab 8: Thrust measurement of a Ramjet engine*	*Lab 11: Thrust measurement on a prepared solid propellant*	*Lab 14: Regression rate measurement of hybrid rocket motor*

Duration (hour)		15	15	15	15	15
S-11	SLO-1	Characteristic velocity and Thrust coefficient	Composition and processing	Burn rate index for stable operation	Thrust chamber	Nuclear rockets
	SLO-2	Numerical Problems on nozzle performance	Liquid propellants	Action time and burn time	Cooling of Thrust chamber	
S-12	SLO-1	Performance parameters and Efficiencies of rocket	Classifications of liquid propellant	Design of Solid Propellant rocket	Cryogenic propulsion system	Solar Propulsion system
	SLO-2	Numerical Problems on Performance parameters and Efficiencies of rocket	Storability of liquid propellant		Special features of cryogenic systems	
S-13	SLO-1	Staging and Clustering of rocket	Numerical Problems on chemical propellant	Numerical Problems on Solid Propulsion system	Numerical Problems on Liquid Propulsion system	Numerical problems
	SLO-2	Numerical Problems on Staging and Clustering of rocket				
S 14-15	SLO-1	Lab 3: Determination of convective heat transfer coefficient over a flat plate by natural convection	Lab 6: Characteristic plots of a wall jet through a non-circular orifice	Lab 9: Solid Rocket motor propellant preparation	Lab 12: Study of Liquid propulsion system	Lab 15: Thrust measurement of a hybrid rocket
	SLO-2					

Learning Resources	1. Ramamurthi.K, "Rocket propulsion", Laxmi Publications, India, Second edition 2016. 2. George P. Sutton, Oscar Biblarz, "Rocket propulsion elements", Wiley India Pvt Ltd. eighth Edition2010.	3. Philip Hill and Carl Peterson, "Mechanics and thermodynamics of propulsion", Pearson India, secondedition 2010. 4. Stephen R. Turns, "An Introduction to Combustion: Concepts and Applications", McGraw-HillEducation, third Edition , 2011.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	20 %	20 %	15 %	15 %	15 %	15 %	15 %	15 %	15 %	15 %
Level 2	Apply Analyze	20 %	20 %	20 %	20 %	20 %	20 %	20 %	20 %	20 %	20 %
Level 3	Evaluate Create	10 %	10 %	15 %	15 %	15 %	15 %	15 %	15 %	15 %	15 %
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Raja, Senior Principal Scientist and Professor, NAL – Bangalore. raja@nal.res.in	1. Dr P K Dash Professor and HOD at Nitte Meenakshi Institute of Technology Bengaluru, Karnataka, India	1. Mr.G.Saravanan, SRMIST
	2. Dr.K.M.Parammasivam, Professor, MIT-Chennai. mparams@mitindia.edu	3. Mr. A.Vinoth Kumar, SRMIST

Course Code	18ASC304J	Course Name	AIRCRAFT STRUCTURES	Course Category	C	Professional Core	L	T	P	C
							3	0	2	4

Pre-requisite Courses	18ASC201J	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLR-1 :	*Understand the physical meaning of symmetric bending and unsymmetrical bending*																		
CLR-2 :	*Know the procedure to fid the shear flow and shear center in open sections subjected to shear loads*																		
CLR-3 :	*Know the procedure to find the shear flow and shear center in closed sections subjected to shear loads*																		
CLR-4 :	*Know the procedure to find the shear flow in closed sections subjected to torque*																		
CLR-5 :	*Understand the buckling analysis of plates*																		
CLR-6 :	*Learn the experimental procedure of stress analysis in wing and fuselage*																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*																		
CLO-1 :	*Explain the differences between symmetrical bending and unsymmetrical bending*	2	85	75	H	H	H	H	-	H	H	H	-	-	-	M	M	M	M
CLO-2 :	*Improve the ability in solving geometrical applications of a structure*	2	85	75	H	H	H	H	-	H	H	H	-	-	-	M	M	M	M
CLO-3 :	*Gain the ability to solve the shear flow analysis and shear centre of open section beams*	2	85	75	H	H	H	H	-	H	H	H	-	-	-	M	M	M	M
CLO-4 :	*Solve the shear flow and shear center calculations in closed sections subjected to both shear loads and torsion loads.*	2	85	75	H	H	H	H	-	H	H	H	-	-	-	M	M	M	M
CLO-5 :	*Describe the buckling modes of thin plates for various end conditions*	2	85	75	H	H	H	H	H	H	H	H	-	-	-	M	M	M	M
CLO-6 :	*Describe the stress analysis in wing and fuselage*	2	85	75	H	H	H	H	H	H	H	H	-	-	-	M	M	M	M

Duration (hour)		15	15	15	15	15
S-1	SLO-1	*Introduction to symmetrical bending*	*Introduction to thin walled beams*	*Concept of Bredt - Batho theory and assumptions for Engineers Theory of bending.*	*Introduction to thin plates and its application to aircraft structures.*	*Shear distribution for wings*
	SLO-2	*Concept of bending stresses in beams of symmetrical sections*	*Section properties of thin walled beams*	*Derivation of the relation between shear flow and the torque*	*Plate subjected to pure bending.*	*Numerical solving*
S-2	SLO-1	*Symmetrical bending, assumptions*	*Concept of shear flow and the shear centre.*	*Multi cell structure subjected to torque, shear flow determination*	*Flexural rigidity of a plate, anticlastic and synclastic surface*	*Bending moment distribution for wings*
	SLO-2	*Direct stress distribution*	*Introduction to thin walled open section beams, assumptions*	*Numerical solving*	*Plate subjected to bending and twisting*	*Numerical solving*
S-3	SLO-1	*Anticlastic bending, unsymmetrical bending, sign conventions and notation, Resolution of bending moments.*	*General stress, strain and displacement relationship for open thin-walled beams.*	*Shear flow and shear centre etermination, and shear flow distribution for a thin-walled symmetrical (three cell) closed sections subjected to torque.*	*Determination of shear strain for thin plates*	*Shear distribution for fuselage*
	SLO-2	*Derivation for bending stress expression due to bending.*	*Shear flow expression for open sections.*	*Numerical solving*	*Plates subjected to a distributed transverse load*	*Numerical solving*
S-4	SLO-1 SLO-2	*Lab 1: Determination of the position of principal axes of a Z section*	*Lab 4: Verification of principle of superposition (Cantilever beam)*	*Lab 7: Determination of shear center of closed section beam*	*Lab 10: Determination of the buckling stress of a given column*	*Lab 13: Study of free and forced vibration analysis*
S-5	SLO-1	*Position of neutral axis, calculation of section properties, Second moments of*	*Shear flow of C section*	*Shear flow and shear centre determination, and shear flow distribution for a thin-walled*	*Plate element subjected to bending, twisting and transverse loads.*	*Bending moment distribution for fuselage*

Duration (hour)		15	15	15	15	15
		area of an inclined thin section and a semicircular section		symmetrical (single cell) closed sections subjected to shear force		
	SLO-2	Approximations for thin-walled sections	Shear flow of C section	Derivation of shear flow for closed section	Numerical solving	Numerical Solving
S-6	SLO-1	Bending of symmetric sections with symmetric loads - Numericals	Shear center of C section	Closed section single cell -shear flow determination	Boundary conditions for various types of edge supports	Shear resistant web beams.
	SLO-2	Numerical solving	Procedure of solving shear centre of c section	Numerical solving	Numerical solving	Numerical solving
S-7	SLO-1	Bending of symmetric sections with skew loads – Problems.	Shear flow distribution for thin walled open sections	Closed section two cell structure-shear flow determination	Combined bending and in-plane loading of a thin rectangular plate	Typical wing structural arrangement, wing strength requirements.
	SLO-2	Numerical solving	Shear center position for different type of thin walled open section	Numerical solving	Numerical solving	Numerical solving
S-8	SLO-1 SLO-2	Lab 2: Verification of Maxwell's reciprocal theorem(Cantilever beam)	Lab 5: Verification of principle of superposition (Simply supported beam)	Lab 8: Analysis of constant strength beam	Lab 11: Determination of the ratio of forces carried by two wires of different materials supported by hinged bar	Lab 14:Preparation of a composite laminate
S-9	SLO-1	Bending stress determination for symmetrical section with stringers.	Shear flow and shear centre determination, and shear flow distribution for thin-walled symmetrical open sections	Shear flow and shear centre determination, and shear flow distribution for a thin-walled symmetrical (single cell) closed sections subjected to shear force.	Buckling of thin plates	Tension (Wagner's) field beam – complete diagonal tension field beams.Derivation
	SLO-2	Numerical solving	Numerical solving	Numerical solving	Numerical solving	Incomplete diagonal tension field beams
S-10	SLO-1	Bending of unsymmetric sections with skew loads - Problems	Shear flow and shear centre determination, and shear flow distribution for thin-walled unsymmetrical open sections	Shear flow and shear centre determination, and shear flow distribution for a thin-walled symmetrical (two cell) closed sections subjected to shear force.	Inelastic buckling of plates	Typical wing structural arrangement, wing strength requirements.
	SLO-2	Numerical solving	Numerical solving	Numerical solving	Numerical solving	Beam theory assumptions, wing stress analysis methods.
S-11	SLO-1	Bending stress determination for unsymmetrical section with stringers.	Concept of structural idealization.	Shear flow and shear centre determination, and shear flow distribution for symmetrical and unsymmetrical (single cell) closed sections with stringers subjected to shear force	Local instability and Instability of stiffened panels	Shear lag concepts
	SLO-2	Numerical solving	Determination of boom areas	Numerical solving	Numerical solving	Basic fuselage structure, fuselage stress analysis methods.
S-12	SLO-1 SLO-2	Lab 3: Verification of Maxwell's reciprocal theorem(Simply supported beam)	Lab 6: Determination of shear center of open section beam	Lab 9: Determination of principal axes of a hollow shaft subjected to both bending and torsional loads	Lab 12:Determination of hoop stress and longitudinal stress in a thin walled pressure vessel	Lab 15:Design aspect of tension field beam
S-13	SLO-1	Bending of thin symmetric sections with symmetric loads - Problems	Shear flow and shear centre determination, and shear flow distribution for symmetrical open sections with stringers.	Shear flow and shear centre determination, and shear flow distribution for symmetrical and unsymmetrical (two cells) closed sections with stringers subjected to shear force.	Flexural–torsional buckling of thin-walled columns	shear flow distribution in the web of the tapered beam
	SLO-2	Numerical solving	Numerical solving	Numerical solving	Numerical solving	Calculation of direct stress due to bending in a fuselage

Duration (hour)		15	15	15	15	15
S-14	SLO-1	*Bending of thin unsymmetric sections with skew loads - Problems.*	*Shear flow and shear centre determination, and shear flow distribution for a unsymmetrical open sections with stringers.*	*Shear flow and shear centre determination, and shear flow distribution for symmetrical and unsymmetrical (three cells) closed sections with stringers subjected to shear force.*	*Estimation of crippling stress using Needham's and Gerard's method.*	*shear flow distribution in the fuselage*
	SLO-2	*Numerical solving*	*Numerical solving*	*Numerical solving*	*Stiffened panel / Sheet effective width concepts*	*Principles of stiffener / web construction*
S-15	SLO-1	*Bending of thin symmetric sections with skew loads - Problems.*	*Walls effective in bending*	*Walls effective in bending*	*Inter rivet and sheet wrinkling failures.*	*Fuselage frames*
	SLO-2	*Numerical solving*	*Walls ineffective in bending*	*Walls ineffective in bending*	*Thin walled column strength, Torsional instability of thin walled columns.*	*Wing ribs*

Learning Resources	1. *Megson T H G,'Aircraft Structures for Engineering Students', Elsevier, Fifth edition, 2013* 2. *Bruhn. E.F., 'Analysis and Design of Flight Vehicles Structures', Tri-state offset company, USA 1985* 3. *Aircraft Structures Laboratory manual*	4. *Rivello, R.M., Theory and Analysis of Flight Structures, McGraw Hill, 1993.* 5. *Peery, D.J., Aircraft Structures, 2md edition, McGraw-Hill, N.Y., 1999*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
Level 2	Apply Analyze	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
Level 3	Evaluate Create	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Total	100%		100%		100%		100%		100%	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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Course Code	18ASC305T	Course Name	FLIGHT DYNAMICS - II	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	18ASC302T	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Know the importance of stability and control of airplane
CLR-2 :	Learn the concepts of static stability and dynamic stability of airplane
CLR-3 :	Learn longitudinal, lateral and directional stabilities
CLR-4 :	Understand control fixed and control free effects
CLR-5 :	Learn the criteria for stability and instability
CLR-6 :	Learn experimental techniques to measure stability parameters of an airplane using real flight testing

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	Determine the degree of stability of any airplane configuration	5	85	90	H	M	M	H	L	-	H	-	-	-	-	H	H	H	-
CLO-2 :	Design an airplane for the required degree of stability and maneuverability	3	80	85	M	M	M	M	L	-	H	-	M	-	-	H	H	H	-
CLO-3 :	Indicate the different flight techniques for safer flight	4	75	80	M	H	M	H	M	-	H	-	-	-	-	H	H	H	-
CLO-4 :	Perform basic calibration of control surfaces	5	50	75	M	M	M	M	L	-	L	-	M	-	-	H	H	H	M
CLO-5 :	Identify different instability modes in flight and suggest the correct recovery procedure	5	80	80	M	M	H	H	M	M	H	M	H	-	M	H	H	H	-
CLO-6 :	Determine the stability derivatives of a real airplane with real flight testing	4	00	95	M	H	M	M	M	-	-	-	M	M	-	H	-	H	M

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Basic concepts of stability and control	Longitudinal control- basics	Dynamic stability- basics	Construction of stability matrix	Lateral- directional equations of motion
	SLO-2	Classification of stability- static and dynamic	Various factors affecting the design of control surface	Rigid body equation of motion for a disturbed flight- Forces	Decoupling of longitudinal and lateral modes	Spiral approximation- spiral divergence
S-2	SLO-1	Longitudinal static stability – basic criteria	Control effectiveness- elevator effectiveness	Rigid body equation of motion for a disturbed flight- moment	Significance of eigen values and eigen vectors of stability matrix	Directional divergence
	SLO-2	Wing contribution to longitudinal static stability	Solving problems	Defining equations of motion in inertial frame of reference	Solving problems	Dutch roll approximation
S-3	SLO-1	Tail contribution (Aft tail contribution) to longitudinal static stability	Elevator angle to trim	Euler angles	Solving Problems	Routh's criterion
	SLO-2	Solving problems	Solving problems	Orientation and position of the airplane	Longitudinal motion-stick fixed	Wing stall characteristics
S-4	SLO-1	Fuselage contribution	Elevator hinge moment	Gravitational and thrust forces	Second order differential equations	Autorotation and its recovery
	SLO-2	Power plant contribution	Stick free neutral point- definition	Small disturbance theory- assumptions	Variation of response with damping ratio	Spin (stalled) and its recovery
S-5	SLO-1	Canard configuration (Forward tail surface) contribution to longitudinal static stability	Relation between stick fixed and stick free neutral point	Small disturbance theory-linearized longitudinal rigid body equation of motion	Pure pitching motion	Aeroelastic effects- wing torsional divergence
	SLO-2	Stick fixed neutral point- definition	Aerodynamic balancing- basics	Small disturbance theory-linearized lateral rigid body equation of motion	State variable representation of the equations of motion	Aeroelastic effects- control reversal
S-6	SLO-1	Solving problems	Various methods of aerodynamic balancing- Set back hinge, horn balance	Aerodynamic force and moment representation by stability coefficient	Solving problems	Aeroelastic effects- control surface flutter

Duration (hour)		9	9	9	9	9
	SLO-2	*Basic criteria for longitudinal, roll and directional stability*	*Various methods of aerodynamic balancing- Frise aileron, sealed nose balance and servo tab*	*Derivatives due to the change in forward speed*	*Longitudinal approximations*	*Stick fixed neutral point*
S-7	SLO-1	*Contribution of various components to roll stability*	*Trim tabs*	*Derivatives due to the change in pitching velocity*	*Phugoid and short period oscillations*	*Determination of stick fixed neutral point- parameters*
	SLO-2	*Dihedral effect and roll control*	*Critical conditions of stability and control*	*Derivatives due to the time rate of change of angle of attack*	*Influence of stability derivative on the longitudinal modes of motion*	*Determination of stick free neutral point- parameters*
S-8	SLO-1	*Solving problems*	*Static margin and neutral point- definition*	*Derivatives due to the rolling rate*	*Lateral motion – stick fixed*	*Determination of stick fixed maneuvering point- parameters*
	SLO-2	*Directional stability- basics*	*Stick forces and stick force gradients- definition*	*Derivatives due to the yawing rate*	*Pure rolling motion*	*Determination of stick free maneuvering point- parameters*
S-9	SLO-1	*Various requirements of rudder for directional control*	*Solving problems*	*Solving problems*	*Tutorial*	*Tutorial*
	SLO-2	*Solving problems*	*Solving problems*	*Solving problems*	*Tutorial*	*Tutorial*

Learning Resources	1. *Nelson, R,C.,"Flight Stability and Automatic Control", McGraw Hill, 1989* 2. *Bernard Etkin "Dynamics of atmospheric flight" Wiley, 1972*	3. *Perkins, C, D., and Hage, R,E., "Airplane Performance, Stability and Control," Wiley Toppan, 1974..* 4. *Babister, A, W.,"Aircraft Stability and Response", Pergamon Press,1980.* 5. *L J Clancy "Aerodynamics" John Wiley & Sons (1975)*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
Level 2	Apply Analyze	*40 %*	-	*40 %*	-	*40 %*	-	*40 %*	-	*40%*	-
Level 3	Evaluate Create	*20 %*	-	*30 %*	-	*30 %*	-	*30 %*	-	*30%*	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in*	1. *Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	1. *Mr. M. Vignesh Kumar, SRMIST*
2. *Wg.Cdr K.Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com*	2. *Dr. P. K Dash, Nitte Meenakshi Institute of Technology, Bangalore, drpdash@gmail.com*	2. *Mr. K. Allwyn, SRMIST*

Course Code	18ASC306T	Course Name	INTRODUCTION TO SPACE TECHNOLOGY	Course Category	C	Professional Core	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*18ASC101T, 18MAB102T*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	Data Book / Codes/Standards	*Nil*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Learn about fundamental laws that govern the orbital dynamics.*
CLR-2 :	*Understand and apply the basic equations of orbital dynamics for different conic orbits.*
CLR-3 :	*Understand the importance of Keplerian orbital elements, Kepler's equation and orbital perturbations.*
CLR-4 :	*Learn the different types of orbit transfers, basics of interplanetary trajectories.*
CLR-5 :	*Study the governing equations of rocket motion, rocket motion under different conditions.*
CLR-6 :	*Understand the fundamentals of ballistic missile trajectory and its governing equations, errors associated during launching of ballistic missiles.*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design, Research	5: Modern Tool Usage	6: Society & Culture	7: Environment & Sustainability	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO – 3
CLO-1 :	*Acquire knowledge of laws applied in orbital dynamics.*	2	85	75	H	M	L	L	-	-	-	-	-	-	-	L	M	M	M
CLO-2 :	*Analyze the properties of conic orbits using the governing equations of orbital mechanics.*	2	90	80	H	H	M	M	L	-	-	-	-	-	-	L	H	H	M
CLO-3 :	*Apply Kepler's equation, earth's oblateness for positioning the satellite at a desired position in orbit.*	2	80	75	H	M	M	M	-	-	-	-	-	-	-	L	M	M	H
CLO-4 :	*Accrue knowledge of different orbit transfers which can be used for many practical missions.*	2	85	75	H	H	M	M	L	-	-	-	-	-	-	L	H	M	M
CLO-5 :	*Apply the governing equations of rocket motion for different conditions.*	2	80	70	H	M	L	L	-	-	-	-	-	-	-	L	M	H	M
CLO-6 :	*Accrue understanding and importance of ballistic missile trajectory and effectively implement its equations by considering the launching errors.*	2	85	75	H	M	M	L	-	-	-	-	-	-	-	L	M	M	M

Duration (hour)		9	9	9	9	9
S-1	SLO-1	*Laws of Orbital Dynamics - Newton's Laws of Motion*	*Introduction to Coordinate Systems*	*Introduction to Orbital Maneuver, Impulsive Maneuvers*	*Rockets – Introduction, Tsiolkov sky rocket equation, Rocket Parameters*	*Introduction Ballistic missile and its trajectory*
	SLO-2	*Kepler's Laws, Conic Sections*	*Types of Coordinate Systems*			
S-2	SLO-1	*Structure of Upper Atmosphere*	*Time Systems - Definitions*	*Introduction to Single Impulse Maneuver – Adjustment of Heights, Simple Rotation.*	*Rocket Motion – Introduction, Two Dimensional Rocket Motion*	*Free-Flight Range Equation - Derivation*
	SLO-2	*Multi-Body / N-body problem*	*Orbital Elements - Introduction*			
S-3	SLO-1	*Two Body Problem – Introduction*	*Classical / Keplerian Orbital Elements*	*Introduction to Single Impulse Maneuver – Simple Plane Change, Combined Change of Plane and Height*	*Two Dimensional Equations of Motion of Rigid Rockets – Assumptions, Derivation*	*Flight-Path Angle Equation – Derivation*
	SLO-2	*Two Body Equation of Relative Motion – Assumptions, Significance*		*Introduction to Hohmann Transfer*		
S-4	SLO-1	*Orbit / Trajectory Equation*	*Kepler's Equation – Derivation*	*Hohmann Transfer*	*Rocket motion in Free Space*	*Numerical Problems on Free-Flight Range and Flight-Path Angle Equations*
	SLO-2					
S-5	SLO-1	*Constants of Motion – Introduction*	*Numerical Problems on Kepler's Equation*	*Bi-elliptic Transfer*	*Rocket Motion in Homogeneous Gravitational Field*	*Maximum Range Trajectory*
	SLO-2	*Conservation of Specific Angular Momentum*				*Time of Free-Flight*
S-6	SLO-1	*Conservation of Specific Mechanical Energy – Vis-Viva Equation*	*Types of Satellite Orbits*	*Numerical Problems on Hohmann and Bi-elliptic Transfers*	*Introduction to Vertical Flight Trajectory*	*Effect of Earth Rotation - Compensating for the Initial velocity*

Duration (hour)		9	9	9	9	9
	SLO-2					*Numerical Problems on Initial Velocity Compensation*
S-7	SLO-1	*Relating the Constants of Motion to the Geometry of the Orbit*	*Earth's Oblateness and its Effects, Applications – Sun-Synchronous and Molniya Orbits*	*One Tangent Burn Transfer - Introduction*	*Introduction to Constant Pitch Angle and Gravity Turn / Zero-Lift Trajectories*	*Effect of Earth Rotation – Compensating for the Movement of the Target*
	SLO-2	*Proof - Kepler's Second and Third Law*		*Phasing Maneuvers - Introduction*		*Numerical Problems on the Movement of the Target Compensation*
S-8	SLO-1	*Some Important Properties of Individual Conic Orbits – Circular Orbit, Elliptic Orbit*	*Introduction to Orbital Perturbations – Perturbing Forces, Perturbation Techniques – Definitions of Special and General Perturbations*	*Introduction to Inter-planetary Mission Trajectories*	*Introduction to Multi-Stage Rocket and its Types, Restricted Staging and Optimal Staging - Definitions*	*Effect of Launching Errors on Range – Introduction to Down-Range and Cross-Range Errors*
	SLO-2	*Some Important Properties of Individual Conic Orbits – Parabolic Orbit, Hyperbolic Orbit*				
S-9	SLO-1	*Tutorial*	*Tutorial*	*Tutorial*	*Tutorial*	*Tutorial*
	SLO-2					

Learning Resources	
	1. *Howard D. Curtis, Orbital Mechanics for Engineering Students, 4th Edition, Butterworth-Heinemann, 2019.* 2. *William E. Wiesel, Spaceflight Dynamics, 3rd Edition, CreateSpace, 2010.* 3. *Roger R. Bate, Donald D. Mueller & Jerry E. White, Fundamentals of Astrodynamics, Dover Publications, Inc., New York, 1971.* 4. *Ashish Tewari, Atmospheric and Space Flight Dynamics, Springer, 2007.* 5. *Cornelisse J.W., Schoyer H.F.R. & Wakker K.F., Rocket Propulsion and Spaceflight Dynamics, Pitman Publishing Ltd., 1979.* 6. *Martin J. L. Turner, Rocket and Spacecraft Propulsion, 3rd Edition, Springer, 2009.* 7. *Vladimir A. Chobotov, Orbital Mechanics, 3rd Edition, AIAA Education Series, AIAA, 2002.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. Manishankar C., Senior Scientist, NAL, Bangalore*	1. *Prof. Arun Kumar P., Assistant Professor, IIT Jammu*	1. *Dr. S. M. Aravindh Kumar, SRMIST* 2. *Mr. K. Allwyn, SRMIST*

Course Code	18ASC307L	Course Name	AIRCRAFT COMPONENT DRAWING AND COMPUTATIONAL ANALYSIS LABORATORY	Course Category	C	Professional Core	L	T	P	C
							0	0	2	1

Pre-requisite Courses	18ASC201J ,18ASC301J	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	Data Book / Codes/Standards	Gas Table		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	To create 2D Design of aircraft components
CLR-2 :	To create 3-Dimensional Design and assembly of typical aircraft & its components.
CLR-3 :	To create drafting of aircraft components
CLR-4 :	To simulate and evaluate Structural characteristics of beams and aircraft structural components
CLR-5 :	To simulate and evaluate aerodynamic properties of Subsonic and supersonic flow over the objects
CLR-6 :	To simulate and evaluate Heat transfer and combustion process

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning 1: Level of Thinking (Bloom)	Learning 2: Expected Proficiency (%)	Learning 3: Expected Attainment (%)	PLO 1: Engineering Knowledge	PLO 2: Problem Analysis	PLO 3: Design & Development	PLO 4: Analysis, Design, Research	PLO 5: Modern Tool Usage	PLO 6: Society & Culture	PLO 7: Environment & Sustainability	PLO 8: Ethics	PLO 9: Individual & Team Work	PLO 10: Communication	PLO 11: Project Mgt. & Finance	PLO 12: Life Long Learning	PLO 13: PSO - 1	PLO 14: PSO - 2	PLO 15: PSO – 3
CLO-1 :	To familiarize with basic aircraft components	1	80	75	H	L	M	M	H	-	-	-	-	-	-	H	-	H	-
CLO-2 :	To familiarize 3-Dimensional Design of typical aircraft & its components.	3	80	75	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-
CLO-3 :	To familiarize assembly and drafting of aircraft components	3	70	60	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-
CLO-4 :	To familiarize Structural analysis of beams and aircraft structural components	3	70	60	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-
CLO-5 :	To familiarize Subsonic and supersonic flow analysis over the objects	3	70	60	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-
CLO-6 :	To familiarize Heat transfer and combustion analysis	3	70	60	H	H	H	H	H	-	-	-	-	-	-	H	-	H	-

Duration (hour)		06	06	06	06	06
S 1-2	SLO-1 / SLO-2	Lab 1: 2D layout of aircraft wing rib and bulkhead sections	Lab 4: Assembly of Typical Aircraft.	Lab 7: 2D analysis of subsonic flow over bluff /streamlined body.	Lab 10: Simulation of Premixed / Non-Premixed Combustion analysis	Lab 13: Heat transfer analysis over a flat plate with natural / forced convection
S 3-4	SLO-1 / SLO-2	Lab 2: 3D model of aircraft Wing Structure	Lab 5: Drafting of Typical Aircraft.	Lab 8: 2D analysis of supersonic flow over bluff /streamlined body.	Lab 11: structural analysis of beams	Lab 14: Heat transfer analysis over a composite plate with natural / forced convection
S 5-6	SLO-1 / SLO-2	Lab 3: 3D model of aircraft fuselage Structure	Lab 6: Introduction to CFD and Grid independency study	Lab 9: 2D analysis of supersonic flow through C-D Nozzle.	Lab 12: Structural analysis of aircraft wing	Lab 15: Heat Transfer analysis in a Thin Plate using MATLAB code

Learning Resources	Laboratory manual User manual of respective software	Gas Table

Learning Assessment

	Bloom's Level of Thinking	CLA – 1 (10%) Theory	CLA – 1 (10%) Practice	CLA – 2 (15%) Theory	CLA – 2 (15%) Practice	CLA – 3 (15%) Theory	CLA – 3 (15%) Practice	CLA – 4 (10%)# Theory	CLA – 4 (10%)# Practice	Final Examination (50% weightage) Theory	Final Examination (50% weightage) Practice
Level 1	Remember / Understand	-	40%	-	30%	-	30%	-	30%	-	30%
Level 2	Apply / Analyze	-	40%	-	40%	-	40%	-	40%	-	40%
Level 3	Evaluate / Create	-	20%	-	30%	-	30%	-	30%	-	30%
	Total	100 %		100 %		100 %		100 %		100 %	

Continuous Learning Assessment (50% weightage) covers CLA – 1 to CLA – 4.

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. S. Raja, Senior Principal Scientist and Professor, NAL – Bangalore. raja@nal.res.in	*Dr.K.M.Parammasivam, MIT-Chennai. mparams@mitindia.edu*	*1. Mr. R. Mohamed Arif, SRMIST.*
		2. Mr. K. B. RavichandraKumar, SRMIST.

Course Code	18ASC350T	Course Name	COMPREHENSION	Course Category	C	Professional Core	L	T	P	C
							0	1	0	1

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Aerospace Engineering*	Data Book / Codes/Standards		*Machine Data*	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*Acquire skills to solve real world problems in Engineering Graphics Design, Engineering Mechanics and Fluid Mechanics*
CLR-2 :	*Acquire skills to solve problems in Thermodynamics, Aircraft Systems and Instruments and Aircraft Materials, Production Techniques*
CLR-3 :	*Acquire skills to solve real world problems in Applied Solid Mechanics, Incompressible Aerodynamics and Air Breathing Propulsion*
CLR-4 :	*Acquire skills to solve real world problems in Compressible Aerodynamics, Rocket Propulsion and Aircraft Structures*
CLR-5 :	*Acquire skills to solve real world problems for competitive examinations in Aerospace Engineering*
CLR-6 :	*Acquire skills to solve real world problems in the broad domain of Aerospace Engineering*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Learning 1: Level of Thinking (Bloom)	2: Expected Proficiency (%)	3: Expected Attainment (%)	PLO 1: Engineering Knowledge	2: Problem Analysis	3: Design & Development	4: Analysis, Design,	5: Modern Tool Usage	6: Society & Culture	7: Environment &	8: Ethics	9: Individual & Team Work	10: Communication	11: Project Mgt. & Finance	12: Life Long Learning	13: PSO - 1	14: PSO - 2	15: PSO - 3
CLO-1 :	*Practice and gain confidence, competence to solveproblems in Engineering Graphics Design, Engineering Mechanics and Fluid Mechanics*	3	85	80	H	H	H	L	L	L	L	L	L	L	L	L	M	L	M
CLO-2 :	*Practice and gain confidence, competence in Thermodynamics, Aircraft Systems and Instruments, Aircraft Materials, Production Techniques*	3	85	80	H	H	M	L	L	L	L	L	L	L	L	L	M	M	M
CLO-3 :	*Solve problems in Applied Solid Mechanics, Incompressible Aerodynamics and Air Breathing Propulsion*	3	85	80	H	H	M	L	L	L	L	L	L	L	L	L	M	L	M
CLO-4 :	*Practice and gain confidence and competence to solve problems in Compressible Aerodynamics, Rocket Propulsion and Aircraft Structures*	3	85	80	H	H	M	L	L	L	L	L	L	L	L	L	M	M	M
CLO-5 :	*Practice and gain confidence and competence to solveproblems for competitive examinations in Aerospace Engineering*	3	85	80	H	H	H	L	L	L	L	L	L	L	L	L	M	L	M
CLO-6 :	*Practice and gain confidence and competence to solve problems in the broad domain of Aerospace Engineering*	3	85	80	H	H	M	L	L	L	L	L	L	L	L	L	M	M	M

Duration (hour)		3	3	3	3	3
S-1	SLO-1	*Tutorial on Engineering graphics and design*	*Tutorial on Thermodynamics*	*Tutorial on Applied Solid Mechanics*	*Tutorial on Compressible Aerodynamics*	*Problem Solving*
	SLO-2	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*	*Problem Solving*
S-2	SLO-1	*Tutorial on Engineering Mechanics*	*Review of Aircraft Systems*	*Tutorial on Incompressible Aerodynamics*	*Tutorial on Rocket Propulsion*	*Problem Solving*
	SLO-2	*Problem Solving*	*Review of Aircraft Instruments*	*Problem Solving*	*Problem Solving*	*Problem Solving*
S-3	SLO-1	*Tutorial on Fluid mechanics*	*Review of Aircraft Materials*	*Tutorial on Air Breathing Propulsion*	*Tutorial on Aircraft Structures*	*Problem Solving*
	SLO-2	*Problem Solving*	*Review of Production Techniques*	*Problem Solving*	*Problem Solving*	*Problem Solving*

Learning Resources

1. *Ferdinand P. Beer, E. Russell Johnston Jr., David Mazurek, Philip J Cornwell, "Vector Mechanicsfor Engineers: Statics and Dynamics" , McGraw - Hill, New Delhi, Tenth Edition, 2013.*
2. *Irving H. Shames, "Mechanics of Fluids", 4rd Edition, McGraw-Hill, 2003.*
3. *Yunus A. Cengel and Michael A. Boles, "Thermodynamics an engineering approach", 7th ed., , McGraw Hill, 2011*
4. *Cohen. H. Rogers. G.F.C. and Saravanamuttoo. H.I.H.: Gas turbine theory. 4th ed., Pearson*
5. *George P. Sutton, Oscar Biblarz, "Rocket propulsion elements", Wiley India Pvt Ltd.8th ed., 2010*
6. *Anderson, J,D., "Fundamentals of Aerodynamics", McGraw Hill., New York, 6th ed.,,2016*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (100% weightage)								Final Examination	
		CLA – 1 (20%)		CLA – 2 (30%)		CLA – 3 (30%)		CLA – 4 (20%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	*40%*	-	*30%*	-	*30%*	-	*30%*	-	-	-
Level 2	Apply Analyze	*40%*	-	*40%*	-	*40%*	-	*40%*	-	-	-
Level 3	Evaluate Create	*20%*	-	*30%*	-	*30%*	-	*30%*	-	-	-
	Total	100 %		100 %		100 %		100 %		-	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1) Dr. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	*1) Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu*	*1) Mr.G.Mahendra Perumal , SRMIST*
2) Wg.Cdr K.Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com	*2) Dr. P. K Dash, Nitte Meenakshi Institute of Technology, Bangalore, drpdash@gmail.com*	*2) Dr.S.Gurusideswar , SRMIST*