EXCEL ENGINEERING COLLEGE

(Autonomous)
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai
Accredited by NBA, NAAC with "A+" and Recognised by UGC (2f &12B)
KOMARAPALAYAM – 637303

DEPARTMENT OF AERONAUTICAL ENGINEERING
M.E. AERONAUTICAL ENGINEERING
REGULATION 2022
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULAM

I – SEMESTER									
Code No.	Course	Category	Periods / Week			Credits	Maximum Marks		
			L	T	P		CA	FE	Total
Theory Course(s)									
22PMA101	Advanced Mathematical Methods	FC	3	2	0	4	40	60	100
22PAR101	Advanced Propulsion System	PC	3	0	0	3	40	60	100
22PAR102	Theory of Vibrations	PC	3	0	0	3	40	60	100
22PAREXX	Professional Elective – I	PE	3	0	0	3	40	60	100
Theory with Practical Course(s)									
22PAR103	Advanced Aerodynamics	PC	3	0	2	4	50	50	100
22PAR104	Advanced Structural Mechanics	PC	3	0	2	4	50	50	100
Employability Enhancement Course									
22PAR105	Technical Presentation Seminar	MC	0	0	2	1	100	0	100
TOTAL			**18**	**2**	**6**	**22**	**360**	**340**	**700**

II- SEMESTER									
Code No.	Course	Category	Periods / Week			Credits	Maximum Marks		
			L	T	P		CA	FE	Total
Theory Course(s)									
22PAR201	Advanced UAV Design	PC	3	0	0	3	40	60	100
22PAR202	Aircraft Flight Dynamics	PC	3	0	0	3	40	60	100
22PAREXX	Professional Elective – II	PE	3	0	0	3	40	60	100
22PAREXX	Professional Elective – III	PE	3	0	0	3	40	60	100
Theory with Practical Course(s)									
22PAR203	Finite Element Method for Aircraft structure Design	PC	3	0	2	4	50	50	100
22PAR204	Computational Fluid Dynamics for Aerodynamics	PC	3	0	2	4	50	50	100
Employability Enhancement Course									
22PAR205	Technical Presentation Seminar	MC	0	0	2	1	100	0	100

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Total		18	0	6	21	360	340	700

III- SEMESTER

Code No.	Course	Category	Periods / Week			Credits	Maximum Marks		
			L	T	P		CA	FE	Total
Theory Course(s)									
22PEE301	Research Methodology and Intellectual Property Rights	PC	3	0	0	3	40	60	100
22PAREXX	Professional Elective –IV	PE	3	0	0	3	40	60	100
22PAREXX	Professional Elective- V	PE	3	0	0	3	40	60	100
Employability Enhancement Course									
22PAR301	Project Phase – I	EEC	0	0	12	6	50	50	100
Mandatory Course									
22PAR302	Internship Training	MC	2 Weeks			0	100	0	100
Total			**6**	**0**	**12**	**15**	**230**	**170**	**400**

IV- SEMESTER

Code No.	Course	Category	Periods / Week			Credits	Maximum Marks		
			L	T	P		CA	FE	Total
Employability Enhancement Course									
22PAR401	Project Phase – II	EEC	0	0	24	12	50	50	100
Total			**0**	**0**	**24**	**12**	**50**	**50**	**100**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 70

CREDITS SUMMARY

S. No	Category	CREDITS PER SEMESTER				Total Credit (AICTE)	Credits in %
		I	II	III	IV		
1	**FC**	4				**4**	**6**
2	**PC**	14	14	3		**31**	**44**
3	**PE**	3	6	6		**15**	**21**
4	**MC**			0		**0**	**0**
5	**EEC**	1	1	6	12	**20**	**29**
Total		**22**	**21**	**15**	**12**	**70**	**100**

FC - Foundation Course
PC - Professional Core
PE - Professional Electives
EEC - Employability Enhancement Courses
MC - Mandatory Courses (Non-Credit Courses)
CA - Continuous Assessment
FE - Final Examination

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LIST OF PROFESSIONAL ELECTIVES									
Code No.	**Course**	**Category**	**Periods / Week**			**Credits**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
I – SEMESTER (Elective-I)									
22PARE01	Boundary Layer Theory	PE	3	0	0	3	40	60	100
22PARE02	Aircraft Design	PE	3	0	0	3	40	60	100
22PARE03	Theory of Elasticity	PE	3	0	0	3	40	60	100
22PARE04	Rocketry and Space Mechanics	PE	3	0	0	3	40	60	100
22PARE05	Experimental Stress Analysis	PE	3	0	0	3	40	60	100
II- SEMESTER (Elective-II & III)									
22PARE11	Theory of Plates and Shells	PE	3	0	0	3	40	60	100
22PARE12	High Temperature Problems in Structures	PE	3	0	0	3	40	60	100
22PARE13	Fatigue and Fracture Mechanics	PE	3	0	0	3	40	60	100
22PARE14	Industrial Aerodynamics	PE	3	0	0	3	40	60	100
22PARE15	Hypersonic Aerodynamics	PE	3	0	0	3	40	60	100
22PARE16	Computational Heat Transfer	PE	3	0	0	3	40	60	100
22PARE17	Wind Power Engineering	PE	3	0	0	3	40	60	100
22PARE18	Advanced Composite Materials and Structures	PE	3	0	0	3	40	60	100
III- SEMESTER (Elective-IV & V)									
22PARE21	Aero Elasticity	PE	3	0	0	3	40	60	100
22PARE22	Design and Analysis of Turbomachines	PE	3	0	0	3	40	60	100
22PARE23	Helicopter Aerodynamics	PE	3	0	0	3	40	60	100
22PARE24	Experimental Aerodynamics	PE	3	0	0	3	40	60	100
22PARE25	High Temperature Gas Dynamics	PE	3	0	0	3	40	60	100
22PARE26	High Speed Jet Flows	PE	3	0	0	3	40	60	100
22PARE27	Combustion in Jet and Rocket Engines	PE	3	0	0	3	40	60	100
22PARE28	Propeller Aerodynamics	PE	3	0	0	3	40	60	100
22PARE29	Aircraft Guidance and Control	PE	3	0	0	3	40	60	100
22PARE30	Avionics	PE	3	0	0	3	40	60	100
22PARE31	Wind Tunnel Techniques	PE	3	0	0	3	40	60	100

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22PMA101	Advanced Mathematical Methods	L	T	P	C
		3	2	0	4
Nature of Course	**Foundation Course**				
Pre requisites	**Aircraft structures ,Propulsion, Avionics**				

Course objectives:

The course is intended to

1. The main objective of this course is to provide the student with a repertoire of mathematical methods that are essential to the solution of advanced problems encountered in the fields of applied physics and engineering.
2. This course covers a broad spectrum of mathematical techniques such as Laplace Transform, Fourier Transform, Calculus of Variations, Conformal Mapping and Tensor Analysis.
3. Application of these topics to the solution of problems in physics and engineering is stressed.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Application of Laplace and Fourier transforms to initial value, initial–boundary value and boundary value problems in Partial Differential Equations	Apply
CO2	Maximizing and minimizing the functional that occur in various branches of Engineering Disciplines	Apply
CO3	Construct conformal mappings between various domains and use of conformal mapping in studying problems in physics and engineering particularly to fluid flow and heat flow problems	Apply
CO4	Understand tensor algebra and its applications in applied sciences and engineering and develops ability to solve mathematical problems involving tensors.	Apply
CO5	Competently use tensor analysis as a tool in the field of applied sciences and related fields.	Apply

Course contents:

UNIT I Laplace Transform Techniques For Partial Differential Equations **12**

Laplace transform: Definitions — Properties — Transform error function — Bessel's function - Dirac delta function – Unit step functions – Convolution theorem – Inverse Laplace transform: Complex inversion formula – Solutions to partial differential equations: Heat equation – Wave equation.

UNIT II Fourier Transform Techniques For Partial Differential Equations **12**

Fourier transform: Definitions — Properties — Transform of elementary functions — Dirac delta function — Convolution theorem — Parseval's identity — Solutions to partial differential equations: Heat equation — Wave equation — Laplace and Poisson's equations.

UNIT III Calculus of Variations **12**

Concept of variation and its properties – Euler"s equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – Isoperimetric problems – Direct methods – Ritz and Kantorovich methods.

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UNIT IV Conformal Mapping and Applications **12**

Introduction to conformal mappings and bilinear transformations – Schwarz Christoffel transformation – Transformation of boundaries in parametric form – Physical applications: Fluid flow and heat flow problems.

UNIT V Tensor Analysis **12**

Summation convention – Contravariant and covariant vectors – Contraction of tensors – Inner product — Quotient law — Metric tensor — Christoffel symbols — Covariant differentiation — Gradient-Divergence and curl.

Total: 60 Periods

References

1. Andrews L.C. and Shivamoggi, B., "Integral Transforms for Engineers", Prentice Hallof India Pvt. Ltd., New Delhi, 2003.
2. Elsgolc, L.D., "Calculus of Variations", Dover Publications Inc., New York, 2007.
3. Mathews, J. H., and Howell, R.W., "Complex Analysis for Mathematics and Engineering", 5th Edition, Jones and Bartlett Publishers, 2006.
4. Kay, D. C., "Tensor Calculus", Schaum's Outline Series, Tata McGraw Hill Edition, 2014.
5. Naveen Kumar, "An Elementary Course on Variational Problems in Calculus ", Narosa Publishing House, 2005.
6. Saff, E.B and Snider, A.D, "Fundamentals of Complex Analysis with Applications in Engineering, Science and Mathematics", 3rd Edition, Pearson Education, New Delhi, 2014.

Mapping of Course Outcomes (CO) with Program Outcomes (PO) Program Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12			
CO1	3	-	3	1	1	-	-	-	-	-	-	2			
CO2	3	-	3	3	3	-	-	-	-	-	-	2			
CO3	3	-	3	3	1	-	-	-	-	-	-	2			
CO4	3	-	3	3	2	-	-	-	-	-	-	1			
CO5	3	-	3	3	3	-	-	-	-	-	-	1			
	3	High				-					2	Medium			

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

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Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

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22PAR101	Advanced Propulsion System	L	T	P	C
		3	0	0	3
Nature of Course	**Professional Core**				
Pre requisites	**Aircraft Propulsion**				

Course objectives:

The course is intended to

1. To impart knowledge to students about fundamental principles of aircraft hypersonic and rocket propulsion
2. To be able to describe the principal design parameters and constraints that set the performance of gas turbine engines and performance parameters.
3. Understanding the workings of multistage compressor or turbine, and to be able to use velocity triangles and the Euler Turbine Equation to estimate the performance of a compressor or turbine stage.
4. To impart, make students understand applications of Propeller Theory.
5. To be able to be familiar with electric nuclear and solar space propulsion methods.

Course Outcomes

On successful completion of the course, students will be able

CO. No.	Course Outcome	Bloom'sLevel
CO1	To able to analyze the overall performance of propulsive systems	Apply
CO2	To explain the design parameters and constraints for Propeller	Apply
CO3	To recognize the working and performance characteristics of Engine Components	Apply
CO4	To explain the design parameters and constraints for Compressor	Apply
CO5	To familiar with electric nuclear and solar space propulsion methods.	Understand

Course contents:

UNIT I Elements of Aircraft Propulsion **9**

Classification of power plants - Methods of aircraft propulsion – Propulsive efficiency – Specific fuelconsumption - Thrust and power- Factors affecting thrust and power- Illustration of working of Gas turbine engine - Characteristics of turboprop, turbofan and turbojet, Ram jet, Scram jet – Methodsof Thrust augmentation.

UNIT II Propeller Theory **9**

Momentum theory, Blade element theory, combined blade element and momentum theory, propeller power losses, propeller performance parameters, prediction of static thrust- and in flight, negative thrust, prop fans, ducted propellers, propeller noise, propeller selection, propeller charts.

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UNIT III Inlets, Nozzles and Combustion Chamber **9**

Subsonic and supersonic inlets – Relation between minimum area ratio and external deceleration ratio – Starting problem in supersonic inlets –Modes of inlet operation, jet nozzle – Efficiencies – Over expanded, under and optimum expansion in nozzles – Thrust reversal. Classification of Combustion chambers - Combustion chamber performance – Flame tube cooling – Flame stabilization.

UNIT IV Axial Flow Compressors, Fans and Turbines **9**

Introduction to centrifugal compressors- Axial flow compressor- geometry- twin spools- three spools- stage analysis- velocity polygons- degree of reaction – radial equilibrium theory- performance maps- axial flow turbines- geometry- velocity polygons- stage analysis- performance maps- thermal limit of blades and vanes.

UNIT V Rocket and Electric Propulsion **9**

Introduction to rocket propulsion – Reaction principle – Thrust equation – Classification of rockets based on propellants used – solid, liquid and hybrid – Comparison of these engines with special reference to rocket performance – electric propulsion – classification- electro thermal – electro static – electromagnetic thrusters- geometries of Ion thrusters- beam/plume characteristics – hall thrusters.

Total: 45 Periods

Text books

1. Hill, P.G. & Peterson, C.R. “Mechanics & Thermodynamics of Propulsion” Pearson education(2009)
2. Jack Mattingly, Elements of Gas Turbine Propulsion, Tata McGraw Hill Education (India) Pvt Ltd,1st Edition, 2005

References

1. Cohen, H. Rogers, G.F.C. and Saravanamuttoo,H.I.H, Gas Turbine Theory, Longman,1989
2. G.P.Sutton, “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 5th Edition,1986.
3. Hill, P.G. and Peterson, C.R. Mechanics and Thermodynamics of Propulsion, Addison – WesleyLongman Inc. 1999
4. W6.. Mathur, M.L., and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, StandardPublishers and Distributors, Delhi, 2014.

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	Pos												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12			
CO1	1	1	2	2	-	-	-	-	2	-	2	-	-	-	-
CO2	1	2	2	2	-	-	-	-	2	-	2	-	-	-	-
CO3	2	3	2	2	-	-	-	-	2	-	2	-	-	-	-
CO4	1	2	2	2	-	-	-	-	2	-	2	-	-	-	-
CO5	1	2	2	2	-	-	-	-	2	-	2	-	-	-	-
	3	High				2	Medium				1	Low			

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Formative assessment			
loom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

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22PAR102	Theory of Vibrations	L	T	P	C
		3	0	0	3
Nature of Course	**Professional core**				
Pre requisites	**Mechanics of machines, aero elasticity, Basic of mechanical vibrations**				

Course objectives:

The course is intended to

1. To study the effect of time dependent forces on mechanical systems and to get the natural characteristics of system with more degree of freedom systems.
2. To study the aero elastic effects of aircraft wing.
3. students will learn the dynamic behavior of different aircraft components and the interaction among the aerodynamic, elastic and inertia forces

Course outcomes:

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom'sLevel
CO1	Explain about the free, forced, damped, undamped and vibrationmeasuring instrument.	Apply
CO2	Calculate natural frequency for two Degrees and Multi degrees ofFreedom Systems.	Apply
CO3	Measure the frequency of a continuous system.	Apply
CO4	Estimate the natural frequency of a system using approximate methods.	Apply
CO5	Identify the effects of vibrations on aircraft structures and the change in aerodynamic property of the structures	Understand

Course contents:

UNIT I Single Degree of Freedom Systems **10**

Simple harmonic motion, definition of terminologies, Newton's Laws, D'Alembert's principle, Energy methods. Free and forced vibrations with and without damping, base excitation, and vibration measuring instruments.

UNIT II Multi-Degrees of Freedom Systems **12**

Two degrees of freedom systems, Static and dynamic couplings, eigen values, eigen vectorsand orthogonality conditions of eigen vectors, Vibration absorber, Principal coordinates, Principal modes. Hamilton"s Principle, Lagrange"s equation and its applications.

UNIT III Vibration of Elastic Bodies **10**

Transverse vibrations of strings, Longitudinal, Lateral and Torsional vibrations. Approximate methods for calculating natural frequencies.

UNIT IV Eigen Value Problems & Dynamic Response of Large Systems **8**

Eigen value extraction methods – Subspace hydration method, Lanczos method – Eigen value reduction method – Dynamic response of large systems – Implicit and explicit methods.

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UNIT V Elements of Aeroelasticity **5**

Aeroelastic problems – Collar‟s triangle of forces – Wing divergence – Aileron control reversal – Flutter.

Total: 45 Periods

References

1. F.S. Tse., I.F. Morse and R.T. Hinkle, “Mechanical Vibrations”, Prentice-Hall of India,2008.
2. Fung, Y.C., “An Introduction to the Theory of Aeroelasticity”, John Wiley & Sons Inc.,New York, 2005.
3. Kenneth G. McConnell, Paulo S. Varoto Vibration Testing: Theory and Practice 2nd Edition, 2008
4. Meirovitch, L. “Elements of Vibration Analysis”, McGraw-Hill Inc.,2006.
5. Rao.J.S. and Gupta.K. “Theory and Practice of Mechanical Vibrations”, Wiley EasternLtd., New Delhi, 1999.
6. Thomson W.T, Marie Dillon Dahleh, “Theory of Vibrations with Applications”,Prentice Hall, 1997
7. Timoshenko, S. “Vibration Problems in Engineering”, John Wiley & Sons, Inc., 1987.

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**Pos**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12			
CO1	3	1	1	-	-	2	1	1	-	-	1	2			
CO2	3	-	1	1	-	2	1	1	-	-	1	2			
CO3	3	-	1	1	-	2	1	2	-	-	1	2			
CO4	2	-	1	1	1	2	1	1	-	-	1	1			
CO5	1	-	-	1	1	2	1	2	-	-	1	1			
	3	High				2	Medium				1	Low			

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

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22PAR103	Advanced Aerodynamics	L	T	P	C
		3	0	2	4
Nature of Course	Professional core				
Pre requisites	Fluid mechanics and characteristics, boundary layer concept, Elementsof aeronautics				

Course objectives:

The course is intended to

1. To introduce the students the fundamental concepts and topic related to aerodynamics of flight vehicles like fundamental forms of flow, aerodynamic coefficient, incompressible and compressible flow theories, viscous flow measurements and various configuration of aircraft and wings.
2. Students will understand the behaviour of airflow over bodies with particular emphasis on airfoil sections in the incompressible flow regime.
3. Upon completion of the course, students will be in a position to use wind tunnel for pressure and force measurements on various models

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Rephrase the concepts of low speed elementary flows and their combinationsby framing the fundamental governing equations.	Apply
CO2	Illustrate two-dimensional inviscid incompressible flow and vortex flow andpredict the circulation around the aerodynamic bodies.	Apply
CO3	Infer the theory of airfoil and its characteristics along with the potential functionsand transformations.	Apply
CO4	Determine the aerodynamic forces and moments and their coefficients as wellas center of pressure using subsonic wing theory.	Apply
CO5	Experiment with the zones of boundary layer and determine the total drag and its coefficient for flow around the body.	Apply

Course contents:

UNIT I Introduction to Aerodynamics **9**

Hot air balloon and aircrafts, Various types of airplanes, Wings and airfoils, lift and Drag, Centre of pressure and aerodynamic centre, Coefficient of pressure, moment coefficient, Continuity and Momentum equations, Point source and sink, doublet, Free and Forced Vortex, Uniform parallel flow, combination of basic flows, Pressure and Velocity distributions on bodies with and without circulation in ideal and real fluid flows, Magnus effect

UNIT II Incompressible Flow Theory **9**

Conformal Transformation, Kutta condition, Karman – Trefftz profiles, Thin aerofoil Theory and its applications. Vortex line, Horse shoe vortex, Biot - Savart law, lifting line theory

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UNIT III Compressible Flow Theory **9**

Compressibility, Isentropic flow through nozzles, shocks and expansion waves, Rayleigh and Fanno Flow, Potential equation for compressible flow, small perturbation theory, Prandtl- Glauert Rule, Linearised supersonic flow, Method of characteristics

UNIT IV Airfoils, Wings and Airplane Configuration In High Speed Flows **9**

Critical Mach number, Drag divergence Mach number, Shock stall, super critical airfoils, Transonic area rule, Swept wings (ASW and FSW), supersonic airfoils, wave drag, delta wings, Design considerations for supersonic airplanes

UNIT V Viscous Flow and Flow Measurements **9**

Basics of viscous flow theory – Boundary Layer – Displacement, momentum and Energy Thickness – Laminar and Turbulent boundary layers – Boundary layer over flat plate – Blasius Solution Introduction to wind tunnel, Types of wind tunnel, Scale model, Important testing parameters, Calibration of test section, Measurement of force, moment and pressure, scale effect, Flow visualization techniques

Total: 45 Periods

Practical

List of experiments

1. Calibration of subsonic wind tunnel
2. Pressure distribution over a smooth and rough cylinder
3. Pressure distribution over a symmetric aerofoil section
4. Pressure distribution over a cambered aerofoil section
5. Force and moment measurements using wind tunnel balance
6. Pressure distribution over a wing of symmetric aerofoil section
7. Pressure distribution over a wing of cambered aerofoil section
8. Flow visualization studies in incompressible flows
9. Calibration of supersonic wind tunnel
10. Supersonic flow visualization studies

Total: 30 Periods

References

1. E.L. Houghton and N.B. Caruthers, Aerodynamics for Engineering Students, Edward Arnold Publishers Ltd., London (First Indian Edition), 1988
2. J.D. Anderson, “Fundamentals of Aerodynamics”, McGraw-Hill Book Co., New York, 1985.
3. Rathakrishnan.E., Gas Dynamics, Prentice Hall of India, 1995.
4. Shapiro, A.H., Dynamics & Thermodynamics of Compressible Fluid Flow, Ronald Press, 1982.
5. W.H. Rae and A. Pope, “Low speed Wind Tunnel Testing”, John Wiley Publications, 1984.
6. Zucrow, M.J., and Anderson, J.D., Elements of gas dynamics McGraw-Hill Book Co., New York, 1989.

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Mapping of Course Outcomes (CO) with Program Outcomes (PO) Program Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12			
CO1	3	2	3	1	1	-	-	-	-	-	-	2			
CO2	3	2	3	3	3	-	-	-	-	-	-	2			
CO3	3	2	3	3	1	-	-	-	-	-	-	2			
CO4	3	3	3	3	2	-	-	-	-	-	-	1			
CO5	3	2	3	3	3	-	-	-	-	-	-	1			
	3	High				2	Medium				1	Low			

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment						
Bloom's Level	**Continuous Assessment**					**Final Examination (Theory) (50)**
	Theory				**Practical's**	
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**Attendance (5)**	**Rubric based CIA (20)**	
Remember	30	20	10		20	40
Understand	10	20	30		20	40
Apply	10	10	10		10	20
Analyze						
Evaluate						
Create						

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22PAR104	Advanced Structural Mechanics	L	T	P	C
		3	0	2	4
Nature of Course	**Professional core**				
Pre requisites	**Strength of materials, Aircraft structures**				

Course objectives:

The course is intended to

1. To make students learn important technical aspects on theory of bending, shear flow in open and closed sections, stability problems in structures with various modes of loading and also impart knowledge on how to analyze aircraft structural components under various forms of loading.
2. Students will get knowledge on different types of beams and columns subjected to various types of loading and support conditions with particular emphasis on aircraft structural components.
3. To impart practical knowledge to the students on calibration of photoelastic materials determination of elastic constant for composite lamina, unsymmetrical bending of beams, determination of shear centre locations for closed and open sections and experimental studies.
4. Upon completion of the course, students will acquire experimental knowledge on the unsymmetrical bending of beams, finding the location of shear centre, obtaining the stresses in circular discs and beams using photoelastic techniques, calibration of photo — elastic materials.

Course outcomes:

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Estimate the response of statically determinate and indeterminate structures under various loading conditions.	Apply
CO2	Apply the knowledge in strain energy methods to calculate the reactions of various structures.	Apply
CO3	Analyze the column using appropriate methods.	Apply
CO4	Design the structure using different theories of failure.	Apply
CO5	Examine the structural effect due to induced stresses.	Apply

Course contents:

UNIT I Bending of Beams **9**

Elementary theory of bending – Introduction to semi-monocoque structures - Stresses in beams of symmetrical and unsymmetrical sections -Box beams — General formula for bending stresses-principal axes method — Neutral axis method.

UNIT II Shear Flow In Open Sections **9**

Shear stresses in beams – Shear flow in stiffened panels - Shear flow in thin walled open tubes – Shear centre – Shear flow in open sections with stiffeners.

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UNIT III Shear Flow in Closed Sections **9**

Shear flow in closed sections with stiffeners– Angle of twist - Shear flow in two flange and threeflange box beams – Shear centre - Shear flow in thin walled closed tubes - Bredt-Batho theory - Torsional shear flow in multi cell tubes - Flexural shear flow in multi cell stiffened structures.

UNIT IV Stability Problems **9**

Stability problems of thin walled structures– Buckling of sheets under compression, shear, bending and combined loads - Crippling stresses by Needham‟s and Gerard‟s methods–Sheet stiffener panels-Effective width, Inter rivet and sheet wrinkling failures-Tension field web beams (Wagner‟s).

UNIT V Analysis of Aircraft Structural Components **9**

Loads on Wings – Schrenk‟s curve - Shear force, bending moment and torque distribution along the span of the Wing. Loads on fuselage - Shear and bending moment distribution along the length of the fuselage. Analysis of rings and frames.

Total: 45 Periods

Practical

List of experiments

1. Constant strength Beams
2. Buckling of columns
3. Unsymmetrical Bending of Beams
4. Shear Centre Location for Open Section
5. Shear Centre Location for Closed Section
6. Flexibility Matrix for Cantilever Beam
7. Combined Loading
8. Calibration of Photo Elastic Materials
9. Stresses in Circular Disc Under Diametrical Compression – Photo Elastic Method
10. Vibration of Beams with Different Support Conditions
11. Fabrication and Determination of elastic constants of a composite laminate.
12. Wagner beam

Total: 30 Periods

References

1. E.F. Bruhn, “Analysis and Design of Flight Vehicle Structures”, Tristate Offset Co., 1980.
2. Megson, T.M.G; Aircraft Structures for Engineering Students, Edward Arnold, 1995.
3. Peery, D.J. and Azar, J.J., Aircraft Structures, 2nd Edition, McGraw-Hill, New York, 1993.
4. Rivello, R.M., Theory and Analysis of Flight structures, McGraw-Hill, N.Y., 1993.
5. Stephen P. Tinnoshenko & S.woinowsky Krieger, Theory of Plates and Shells, 2nd Edition, McGraw-Hill, Singapore, 1990.

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Mapping of Course Outcomes (CO) with Program Outcomes (PO) Program Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12			
CO1	3	2	3	1	1	-	-	-	-	-	-	2			
CO2	3	3	3	3	3	-	-	-	-	-	-	2			
CO3	3	2	3	3	1	-	-	-	-	-	-	2			
CO4	3	2	3	3	2	-	-	-	-	-	-	1			
CO5	3	3	3	3	3	-	-	-	-	-	-	1			
	3	High				2	Medium				1	Low			

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment						
Bloom's Level	**Continuous Assessment**					**Final Examination (Theory) (50)**
	Theory				**Practical's**	
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**Attendance (5)**	**Rubric based CIA (20)**	
Remember	30	20	10		20	40
Understand	10	20	30		20	40
Apply	10	10	10		10	20
Analyze						
Evaluate						
Create						

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22PAR105	Technical Presentation Seminar	L	T	P	C
		0	0	2	1
Nature of Course	**Mandatory courses**				
Pre requisites	**Undergraduate Project Presentation**				

Course objectives:

The course is intended to

1. To encourage the students to study advanced engineering developments
2. To prepare and present technical reports.
3. To encourage the students to use various teaching aids such as overhead projectors, PowerPoint presentation and demonstration models.

Course outcomes:

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom'sLevel
CO1	To review, prepare and present technological developments	Understand
CO2	To face the placement interviews	Understand
CO3	To improve the speaking skills	Understand
CO4	To develop your confidence in handling information, making useful notes, and presenting an argument	Understand
CO5	To improve the research and development Knowledge	Understand

Course contents:

During the seminar session each student is expected to prepare and present a topic on engineering/ technology, for a given time limit. In a session /period student are expected to present the seminar. Each student is expected to present at least twice during the semester and the student is evaluated based on Rubrics. At the end of the semester, he / she can submit a report on his / her topic of seminar and marks are given based on the report. A Faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also. Evaluation is 100% internal.

Total: 30 Periods

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Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	-	-	-			3	2	3	2	3	2	2	-	-	-
CO2	-	-	-	-	-	1	1	3	3	3	2	2	-	-	-
CO3	-	-	-	-	-	3	1	2	2	2	3	3	-	-	-
CO4	-	-	-	-	-	2	2	3	3	2	3	2	-	-	-
CO5	-	-	-	-	-	3	1	3	2	2	3	3	-	-	-
	3	High					2		Medium			1	Low		

Assessment based on Continuous and Final Examination			
Bloom's Level	**Continuous Assessment (50 marks) (Attendance – 5 marks)**		**Final Examination [50 marks]**
	Rubric based Continuous Assessment [25 marks]	**Model Examination [20 marks]**	
Remember			
Understand	40	40	40
Apply	60	60	60
Analyze			
Evaluate			
Create			

CHAIRMAN - BOARD OF STUDIES

22PAR201	Advanced UAV Design	L	T	P	C
		3	0	0	3
Nature of Course	**Professional core**				
Pre requisites	**Aircraft structures ,propulsion, avionics**				

Course objectives:

The course is intended to

1. To introduce and develop basic concept of UAV design
2. At the end of this course, the student should be able to understand and apply the various concepts related to UAV design.
3. The student should be able to design various structural components of the UAV.
4. The course enables students to understand and develop UAV avionics system.
5. To students familiar the various level UAV airworthiness.

Course outcomes:

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Explore in various stages of UAV design	Apply
CO2	Design and development of UAV structural design	Apply
CO3	Expose in various UAV propulsion system	Apply
CO4	Identify and apply various avionics system	Apply
CO5	Familiar various UAV airworthiness systems	Apply

Course contents:

UNIT I introduction to fixed-wing UAVs **9**

The Stages of Design, Concept Design, Preliminary Design, Detail Design, Manufacturing Design, In-service Design and Decommissioning, the Morphology of a UAV, Main Design Drivers.

UNIT II UAV Structural Design **9**

Wings parts design, Fuselages and Tails design, Undercarriages design, Preliminary Structural Analysis

UNIT III Propulsion System **9**

IC Engines, Electric Motors, Propellers, Engine/Motor Control, Fuel Systems, Batteries and Generators

UNIT IV Airframe Avionics and Systems **9**

Primary Control Transmitter and Receivers, Avionics Power Supplies, Servos, Wiring, Buses, and Boards, Autopilots, Payload Communications Systems, Ancillaries, Resilience and Redundancy

UNITV Airworthiness UAVs **9**

Airworthiness, Failure analysis, Systems Engineering, Geometry/CAD Codes, Operational Simulation and Mission Planning, Aerodynamic and Structural Analysis Codes, Design and DecisionViewing, Supporting Databases.

Total: 45 Periods

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Textbooks

1. Andrew J.Keane,Andras sobester, James P.Scanlan, „Small Unmanned Fixed-wing Aircraft Design a practical approach', John Wiley & Sons Ltd, 2017.
2. Richard K. Barnhart, Stephen B. Hottman,Douglas M. Marshall , Eric Shappee, „Introduction To Unmanned Aircraft Systems",CRC Press, 2012

Reference

1. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Roadto Autonomy", Springer, 2007
2. Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc,1998
3. 3. Dr. Armand J. Chaput, "Design of Unmanned Air Vehicle Systems", Lockheed Martin Aeronautics Company, 2001

Web references

1. https://nptel.ac.in/courses/101/104/101104073/
2. https://www.isro.gov.in/applications-of-unmanned-aerial-vehicle-uav-based-remote-sensing-ne-region

Mapping of Course Outcomes (CO) with Program Outcomes (PO) Program Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12			
CO1	3	-	3	1	1	-	-	-	-	-	-	2			
CO2	3	-	3	3	3	-	-	-	-	-	-	2			
CO3	3	-	3	3	1	-	-	-	-	-	-	2			
CO4	3	-	3	3	2	-	-	-	-	-	-	1			
CO5	3	-	3	3	3	-	-	-	-	-	-	1			
	3	High				2	Medium				1	Low			

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

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22PAR202	Aircraft Flight Dynamics	L	T	P	C
		3	0	0	3
Nature of Course	**Professional core**				
Pre requisites	**Basic of Aircraft Power Plants, Elements of aircrafts**				

Course objectives:

The course is intended to

1. To impart knowledge to students on aircraft performance in level, climbing, gliding
2. To impart knowledge about accelerated flight modes and also various aspects of stability and control in longitudinal, lateral and directional modes.
3. Students will understand the static, dynamic longitudinal, directional and lateral stability and control of airplane, effect of maneuvers.

Course outcomes:

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Evaluate the performance characteristics like aerodynamic forces and power variations of aircraft.	Evaluate
CO2	Interpret the range, endurance, climbing, gliding and various maneuvering performances of an aircraft along with load factor andits limitations.	Analyze
CO3	Illustrate the degrees of freedom and static longitudinal stability attained in aircraft.	Apply
CO4	Correlate the aircraft's lateral and directional stability.	Apply
CO5	Determine the response of aircraft in various oscillatory modes of aircraft stability.	Apply

Course contents:

UNIT I Principles of Flight **9**

Physical properties and structure of the atmosphere, International Standard Atmosphere, Temperature, pressure and altitude relationship, Measurement of speed — True, Indicated and Equivalent air speed, Streamlined and bluff bodies, Various Types of drag in airplanes, Drag polar, Methods of drag reduction of airplanes.

UNIT II Aircraft Performance In Level, Climbing and Gliding Flights **8**

Straight and level flight, Thrust required and available, Power required and available, Effect of altitude on thrust and power, Conditions for minimum drag and minimum power required, Gliding and Climbing flight, Range and Endurance.

UNIT III Accelerated Flight **9**

Take off and landing performance, turning performance, horizontal and vertical turn, Pull up and pull down, maximum turn rate, V-n diagram with FAR regulations.

UNIT IV Longitudinal Stability and Control **10**

Degrees of freedom of a system, static and dynamic stability, static longitudinal stability, Contribution of individual components, neutral point, static margin, Hinge moment, Elevator control effectiveness, Power effects, elevator angle to trim, elevator angle per g, maneuver point, stick force gradient, aerodynamic balancing, Aircraft equations of motion, stability derivatives, stability quartic, Phugoid motion.

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UNIT V Lateral, Directional Stability and Control **9**

Yaw and side slip, Dihedral effect, contribution of various components, lateral control, aileron control power, strip theory, aileron reversal, weather cock stability, directional control, rudder requirements, dorsal fin, One engine inoperative condition, Dutch roll, spiral and directional divergence, autorotation and spin.

Total: 45 Periods

Text books

1. Mc Cornick. W., "Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, NY, 1979.
2. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 2004.
3. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley & Son:, Inc, NY, 1988

References

1. Babister, A.W. Aircraft stability and response, Pergamon Press, 1980.
2. Clancey,L.J. Aerodynamics, Pitman, 1986.
3. Houghton, E.L., and Caruthers, N.B., Aerodynamics for engineering students, Edward Arnold Publishers, 1988.
4. Kuethe, A.M., and Chow, C.Y., Foundations of Aerodynamics, John Wiley & Sons, 1982.
5. McCormic, B.W., Aerodynamics, Aeronautics & Flight Mechanics John Wiley, 1995.
6. Nelson, R.C. Flight Stability & Automatic Control, McGraw-Hill, 1989.
7. Perkins C.D., & Hage, R.E. Airplane performance, stability and control, Wiley Toppan, 1974

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	Pos												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	1	-	-	-	-	-	-	1	-			
CO2	3	3	2	2	-	-	-	-	-	-	2	-			
CO3	3	2	2	2	2	-	-	-	-	-	2	2			
CO4	3	2	2	1	2	-	-	-	-	-	2	2			
CO5	3	3	2	2	2	-	-	-	-	-	2	2			
	3	High				2	Medium				1	Low			

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

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22PAR203	Finite Element Method for Aircraft structure Design	L	T	P	C
		3	0	2	4
Nature of Course	**Professional core**				
Pre requisites	**Basic shapes of elements, 2D, 3D, Boundary conditions**				

Course Objectives:

The course is intended to

1. The course is indented to make students learn using Finite element techniques to solve problems related to discrete, continuum and isoparametric elements.
2. Introduce solution schemes for static, dynamic and stability problems.
3. students will learn the concept of numerical analysis of structural components
4. Upon completion of the course, students will be in a position to use Computational fluid dynamics software and Finite Element Analysis software for solving various aeronautical problems.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom'sLevel
CO1	Apply direct stiffness, Rayleigh -Ritz, Galerkin method to solve engineeringproblems and outline the requirements for convergence	Remember
CO2	Solve linear 1D structural rod, beams and frames problems; evaluate theEigenvalues and Eigenvectors for stepped bar and beam	Analyse
CO3	Solve two dimensional Structural problems FEM method	Apply
CO4	Derive shape functions for 4 and 8 node quadrilateral, 6 node triangle elements and apply numerical integration to solve; 1D and 2D; stiffnessintegrations	Evaluate
CO5	Solution schemes familiarize software packages.	Apply

Course contents:

UNIT I Introduction **9**

Review of various approximate methods — Rayleigh-Ritz, Galerkin and Finite Difference Methods - Stiffness and flexibility matrices for simple cases - Basic concepts of finite element method - Formulation of governing equations and convergence criteria.

UNIT II Discrete Elements **9**

Structural analysis of bar and beam elements for static and dynamic loadings. Bar of varying section – Temperature effects. Program Development and use of software package for application of bar and beam elements for static, dynamic and stability analysis.

UNIT III Continuum Elements **9**

Plane stress, Plane strain and Axisymmetric problems – CST Element – LST Element. Consistent and lumped load vectors. Use of local co-ordinates. Numerical integration. Application to heat transfer problems.Solution for 2-D problems (static analysis and heat transfer) using software packages.

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UNIT IV Isoparametric Elements **9**

Definition and use of different forms of 2-D and 3-D elements. - Formulation of element stiffnessmatrix and load vector.Solution for 2-D problems (static analysis and heat transfer) using software packages.

UNIT V Solution Schemes **9**

Different methods of solution of simultaneous equations governing static, dynamics and stability problems. General purpose Software packages.

Total: 45 Periods

Practical

List of experiments

1. Fatigue analysis of aircraft landing gear using FEM Software.
2. Rotor dynamic analysis of jet engine compressor blade using FEM Software
3. Rotor dynamic analysis of jet engine Turbine blade using FEM Software
4. Fracture Mechanics analysis of aircraft skin structure using FEM Software.
5. Random Vibration analysis of Aircraft Wing Structure.
6. Weight Optimization of Aircraft fuselage frame structure using FEM Software.
7. Stress Optimization of Aircraft fuselage frame structure using FEM Software.
8. Heat transfer analysis of Turbine blade using FEM Software.
9. Heat transfer analysis of rocket thrust chamber using FEM Software.
10. Prediction of Drag and lift on typical aircraft using CFD Software
11. Prediction of Drag and lift typical automobile using CFD Software
12. Flow simulation of propeller using CFD Software
13. Flow simulation of wind Turbine blade using CFD Software
14. Combustion simulation of mini jet engine using CFD Software
15. Combustion simulation of pulse jet engine using CFD Software
16. Acoustic study of jet engine using CFD Software.

Total: 30 Periods

Text books

1. Reddy J.N., "An Introduction to Finite Element Method", McGraw Hill, third edition, 2005.
2. Tirupathi.R. Chandrapatha and Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", Prentice Hall India, Fourth edition, 2012.

References

1. C.S. Krishnamurthy, “Finite Elements Analysis”, Tata McGraw-Hill, 1987.
2. K.J. Bathe and E.L. Wilson, “Numerical Methods in Finite Elements Analysis”, Prentice Hall of India Ltd., 1983.
3. Robert D. Cook, David S. Malkus, Michael E. Plesha and Robert J. Witt “Concepts and Applications of Finite Element Analysis”, 4th Edition, John Wiley & Sons, 2002.
4. S.S.Rao, “Finite Element Method in Engineering”, Butterworth, Heinemann Publishing, 3rd Edition, 1998
5. Segerlind,L.J. “Applied Finite Element Analysis”, Second Edition, John Wiley and Sons Inc., New York, 1984.
6. Tirupathi R. Chandrupatla and Ashok D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall, 2002

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Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**Pos**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12			
CO1	3	3	2	-	-	-	-	-	-	-	1	-			
CO2	2	3	2	-	-	-	-	-	-	-	1	-			
CO3	3	3	2	-	-	-	-	-	-	-	1	-			
CO4	2	2	2	-	-	-	-	-	-	-	-	-			
CO5	3	2	3	-	-	-	-	-	-	-	1	-			
	3	High				2	Medium				1	Low			

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment						
Bloom's Level	**Continuous Assessment**					**Final Examination (Theory) (50)**
	Theory				**Practical's**	
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**Attendance (5)**	**Rubric based CIA (20)**	
Remember	30	20	10		20	40
Understand	10	20	30		20	40
Apply	10	10	10		10	20
Analyze						
Evaluate						
Create						

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22PAR204	Computational Fluid Dynamics for Aerodynamics	L	T	P	C
		3	0	2	4
Nature of Course	**Professional core**				
Pre requisites	**Fluid mechanics, Aerodynamics**				

Course objectives:

The course is intended to

1. Familiar to use various Numerical Technique
2. Understand and apply the concepts of various Grid generation
3. Understand the various two and three dimensional panels technique
4. Understand the various transonic relaxation techniques
5. Solve the time dependent solutions of gas dynamic problems.

Course outcomes:

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Familiar in Numerical Technique	Understand
CO2	Apply the concepts of Grid generation	Apply
CO3	Elements of two and three dimensional panels	Understand
CO4	Understand transonic relaxation techniques	Understand
CO5	Solve time dependent problems	Apply

Course contents:

UNIT I Numerical Solutions Of Some Fluid Dynamical Problems **9**

Basic fluid dynamics equations, Equations in general orthogonal coordinate system, Body fitted coordinate systems, Stability analysis of linear system. Finding solution of a simple gas dynamic problem, Local similar solutions of boundary layer equations, Numerical integration and shooting technique. Numerical solution for CD nozzle isentropic flows and local similar solutions of boundary layer equations.

UNIT II Grid Generation **9**

Need for grid generation – Various grid generation techniques – Algebraic, conformal and numerical grid generation – importance of grid control functions – boundary point control – orthogonality of grid lines at boundaries. Elliptic grid generation using Laplace‟s equations for geometries like airfoil and CD nozzle.

UNIT III Panel Methods **9**

Elements of two and three dimensional panels, panel singularities. Application of panel methods to incompressible, compressible, subsonic and supersonic flows. Numerical solution of flow over a cylinder using 2-D panel methods using both vertex and source panel methods for lifting and non lifting cases respectively

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UNIT IV Transonic Relaxation Techniques **9**

Small perturbation flows, Transonic small perturbation (TSP) equations, Central and backward difference schemes, conservation equations and shock point operator, Line relaxation techniques, Acceleration of convergence rate, Jameson‟s rotated difference scheme -stretching of coordinates, shock fitting techniques Flow in body fitted coordinate system.

UNIT V Time Dependent Methods **9**

Stability of solution, Explicit methods, Time split methods, Approximate factorization scheme, Unsteady transonic flow around airfoils. Some time dependent solutions of gas dynamic problems. Numerical solution of unsteady 2-D heat conduction problems using SLOR method

Total: 45 Periods

Practical

1. Prediction of Drag and lift on typical aircraft using CFD Software
2. Prediction of Drag and lift typical automobile using CFD Software
3. Flow simulation of propeller using CFD Software
4. Heat transfer analysis of 3d Duct using CFD Software
5. Combustion simulation of any engine using CFD Software

Total: 30 Periods

Text books

1. John D. Anderson, JR” Computational Fluid Dynamics”, McGraw-Hill Book Co., Inc., NewYork, 1995.
2. T.J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2002 6. T.K.Bose, “Computation Fluid Dynamics” Wiley Eastern Ltd., 1988

References

1. A.A. Hirsch, „Introduction to Computational Fluid Dynamics”, McGraw-Hill, 1989.
2. C.Y.Chow, “Introduction to Computational Fluid Dynamics”, John Wiley, 1979.
3. H.J. Wirz and J.J. Smeldern “Numerical Methods in Fluid Dynamics”, McGraw-Hill & Co.,1978.

Web References

1. https://nptel.ac.in/courses/112/105/112105045/
2. https://nptel.ac.in/courses/112/107/112107080/
3. https://nptel.ac.in/courses/112/105/112105254/

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	2	2	-	-	-	-	-	2	-	-	-	-
CO2	3	3	2	2	2	-	-	-	-	-	2	-	-	-	-
CO3	3	3	2	2	2	-	-	-	-	-	2	-	-	-	-
CO4	3	3	2	2	2	-	-	-	-	-	2	-	-	-	-
CO5	3	3	2	2	2	-	-	-	-	-	2	-	-	-	-
	3	High				-					2	Medium			

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Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment						
Bloom's Level	**Continuous Assessment**					**Final Examination (Theory) (50)**
	Theory				**Practical's**	
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	**Attendance (5)**	**Rubric based CIA (20)**	
Remember	30	20	10		20	40
Understand	10	20	30		20	40
Apply	10	10	10		10	20
Analyze						
Evaluate						
Create						

CHAIRMAN - BOARD OF STUDIES

22PAR205	Technical Presentation Seminar	L	T	P	C
		0	0	2	1
Nature of Course	**Mandatory courses**				
Pre requisites	**Undergraduate Project Presentation**				

Course objectives:

The course is intended to

1. To encourage the students to study advanced engineering developments
2. To prepare and present technical reports.
3. To encourage the students to use various teaching aids such as overhead projectors, PowerPoint presentation and demonstration models.

Course outcomes:

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom'sLevel
CO1	To review, prepare and present technological developments	Understand
CO2	To face the placement interviews	Understand
CO3	To improve the speaking skills	Understand
CO4	To develop your confidence in handling information, making useful notes, and presenting an argument	Understand
CO5	To improve the research and development Knowledge	Understand

Course contents:

During the seminar session each student is expected to prepare and present a topic on engineering/ technology, for a given time limit. In a session /period students are expected to present the seminar. Each student is expected to present at least twice during the semester and the student is evaluated based on Rubrics. At the end of the semester, he / she can submit a report on his / her topic of seminar and marks are given based on the report. A Faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also. Evaluation is 100% internal.

Total: 30 Periods

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Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	-	-	-			3	2	3	2	3	2	2	-	-	-
CO2	-	-	-	-	-	1	1	3	3	3	2	2	-	-	-
CO3	-	-	-	-	-	3	1	2	2	2	3	3	-	-	-
CO4	-	-	-	-	-	2	2	3	3	2	3	2	-	-	-
CO5	-	-	-	-	-	3	1	3	2	2	3	3	-	-	-
	3	High					2		Medium			1	Low		

Assessment based on Continuous and Final Examination			
Bloom's Level	**Continuous Assessment (50 marks) (Attendance – 5 marks)**		**Final Examination [50 marks]**
	Rubric based Continuous Assessment [25 marks]	**Model Examination [20 marks]**	
Remember			
Understand	40	40	40
Apply	60	60	60
Analyze			
Evaluate			
Create			

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	Review I [10]	Review II [10]	Review III [10]	Publication [10]	Report [10 Marks]	Total [50]	Final Viva Voce Examination [50 marks]
Marks	100	100	100	10	10	50	50

I – SEMESTER (Elective-I)

22PARE01	Boundary Layer Theory	L	T	P	C
		3	0	0	3
Nature of Course	**Professional Elective**				
Pre requisites	**Fluid Mechanics and Aerodynamics**				

Course objectives:

The course is intended to

1. Students will acquire knowledge on viscous fluid flow, development of boundary layer for 2D flows.
2. Students will understand the behaviour of airflow over bodies with particular emphasis on airfoil sections in the incompressible flow regime.
3. Upon completion of the course, students will be in a position to use wind tunnel for pressure and force measurements on various models

Course outcomes:

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Viscous Flow Equations	Apply
CO2	Laminar Boundary Layer	Apply
CO3	turbulent boundary layer	Apply
CO4	Approximate Solution To Boundary Layer Equations	Apply
CO5	Thermal Boundary Layer	Apply

Course contents:

UNIT I Viscous Flow Equations **9**

Navier-Stokes Equations, Creeping motion, Couette flow, Poiseuille flow through ducts, Ekmandrift.

UNIT II Laminar Boundary Layer **9**

Development of boundary layer – Estimation of boundary layer thickness, Displacement thickness-Momentum and energy thicknesses for two dimensional flow – Two dimensional boundary layer equations – Similarity solutions - Blasius solution.

UNIT III turbulent boundary layer **9**

Physical and mathematical description of turbulence, two-dimensional turbulent boundary layer equations, Velocity profiles – Inner, outer and overlap layers, Transition from laminar to turbulent boundary layers, turbulent boundary layer on a flat plate, mixing length hypothesis.

UNIT IV Approximate Solution to Boundary Layer Equations **9**

Approximate integral methods, digital computer solutions – Von Karman – Polhausen method.

UNIT V Thermal Boundary Layer **9**

Introduction to thermal boundary layer – Heat transfer in boundary layer - Convective heat transfer, importance of non dimensional numbers – Prandtl number, Nusselt number, Lewis number etc.

Total: 45 Periods

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References

1. A.J. Reynolds, “Turbulent flows in Engineering”, John Wiley & Sons, 1980.
2. Frank White – Viscous Fluid flow – McGraw Hill, 1998
3. H. Schlichting, “Boundary Layer Theory”, McGraw-Hill, New York, 1979.
4. Ronald L., Panton, “Incompressible fluid flow”, John Wiley & Sons, 1984.
5. Tuncer Cebeci and Peter Bradshaw, “Momentum transfer in boundary layers”, Hemisphere Publishing Corporation, 1977.

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	3	3	-	-	-	-	-	-	2			
CO2	3	2	3	1	1	-	-	-	-	-	-	2			
CO3	3	1	3	3	3	-	-	-	-	-	-	2			
CO4	3	2	3	3	1	-	-	-	-	-	-	2			
CO5	3	1	3	3	2	-	-	-	-	-	-	1			
	3	High				-					2	Medium			

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

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22PARE02	Aircraft Design	L	T	P	C
		3	0	0	3
Nature of Course	**Professional Elective**				
Pre requisites	**Flight dynamics, Aircraft Design Project**				

Course objectives:

The course is intended to

1. To impart knowledge to the students on various types of power plant types and also toexpose them principles of aerodynamics and structural design aspects
2. To encourage the students to study advanced engineering developments

Course outcomes:

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Review of Developments in Aviation	Apply
CO2	Power Plant Types and Characteristics	Apply
CO3	Preliminary Design	Apply
CO4	Special Problems	Apply
CO5	Structural Design	Apply

Course contents:

UNIT I Review of Developments in Aviation **9**

Categories and types of aircrafts – various configurations – Layouts and their relative merits – strength, stiffness, fail safe and fatigue requirements – Manoeuvering load factors – Gust and manoeuverability envelopes – Balancing and maneuvering loads on tail planes.

UNIT II Power Plant Types and Characteristics **9**

Characteristics of different types of power plants – Propeller characteristics and selection – Relative merits of location of power plant.

UNIT III Preliminary Design **9**

Selection of geometric and aerodynamic parameters – Weight estimation and balance diagram – Drag estimation of complete aircraft – Level flight, climb, takeoff and landing calculations – range and endurance – static and dynamic stability estimates – control requirements.

UNIT IV Special Problems **9**

Layout peculiarities of subsonic and supersonic aircraft – optimization of wing loading to achieve desired performance – loads on undercarriages and design requirements.

UNIT V Structural Design **9**

Estimation of loads on complete aircraft and components – Structural design of fuselage, wings and undercarriages, controls, connections and joints. Materials for modern aircraft – Methods of analysis, testing and fabrication.

Total: 45 Periods

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References

1. A.A. Lebedenski, “Notes on airplane design”, Part-I, I.I.Sc., Bangalore, 2005.
2. D.P. Raymer, “Aircraft conceptual design”, AIAA Series, 1988.
3. E. Torenbeek, “Synthesis of Subsonic Airplane Design”, Delft University Press, London, 2011.
4. E.F. Bruhn, “Analysis and Design of Flight Vehicle Structures”, Tristate Offset Co., U.S.A., 1980.
5. G. Corning, “Supersonic & Subsonic Airplane Design”, II Edition, Edwards Brothers Inc., Michigan, 2005.
6. H.N.Kota, Integrated design approach to Design fly by wire” Lecture notes Interline Pub. Bangalore, 1992.
7. Michael Niu , Michael C.Y. Niu ,Airframe Stress Analysis & Sizing 1st Edition 1997

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2			3	2	3	2	3	2	2	-	-	-
CO2	3	2	2	-	-	1	1	3	3	3	2	2	-	-	-
CO3	3	1	2	-	-	3	1	2	2	2	3	3	-	-	-
CO4	3	1	2	-	-	2	2	3	3	2	3	2	-	-	-
CO5	3	2	2	-	-	3	1	3	2	2	3	3	-	-	-
	3	High				-					2	Medium			

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

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22PARE03	Theory of Elasticity	L	T	P	C
		3	0	0	3
Nature of Course	**Professional Elective**				
Pre requisites	**Aircraft Material Process, Composite Materials**				

Course objectives:

The course is intended to

1. To impart knowledge to students on basic governing equations of elasticity, solving of 2D problems in Cartesian and polar coordinates
2. To introduce various theories and methods to solve torsion related problems.

Course outcomes:

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Elastic constants	Apply
CO2	Basic Equations of Elasticity	Apply
CO3	2 - D Problems in Cartesian Coordinates	Apply
CO4	2 - D Problems in Polar Coordinates	Apply
CO5	Torsion	Apply

Course contents:

UNIT I Introduction **6**

Definition, notations and sign conventions for stress and strain – Stress - strain relations, Strain-displacement relations- Elastic constants.

UNIT II Basic Equations of Elasticity **10**

Equations of equilibrium – Compatibility equations in strains and stresses –Boundary Conditions - Saint-Venant‟s principle - Stress ellipsoid – Stress invariants – Principal stresses in 2-D and 3-D.

UNIT III 2 - D Problems in Cartesian Coordinates **9**

Plane stress and plain strain problems - Airy‟s stress function – Biharmonic equations – 2-D problems – Cantilever and simply supported beams.

UNIT IV 2 - D Problems in Polar Coordinates **12**

Equations of equilibrium – Strain – displacement relations – Stress – strain relations – Airy‟s stress function – Use of Dunder‟s table. - Axisymmetric problems - Bending of Curved Bars - Circular Discs and Cylinders – Rotating Discs and Cylinders - Kirsch, Boussinasque‟s and Michell‟s problems.

UNIT V Torsion **8**

Coulomb‟s theory-Navier‟s theory-Saint Venant‟s Semi-Inverse method — Torsion of Circular, Elliptical and Triangular sections - Prandtl‟s theory-Membrane analogy.

Total: 45 Periods

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References

1. E. Sechler, “Elasticity in Engineering” John Wiley & Sons Inc., New York, 1980.
2. Enrico Volterra and Caines, J.H, Advanced strength of Materials, Prentice Hall,1991.
3. S.P. Timoshenko and J.N. Goodier, Theory of Elasticity, McGraw-Hill, 1985.
4. Ugural, A.C and Fenster, S.K, Advanced Strength and Applied Elasticity, Prentice hall, 2003
5. Wang, C.T. Applied elasticity, McGraw Hill 1993

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	3	3	-	-	-	-	-	-	2			
CO2	3	2	3	1	1	-	-	-	-	-	-	2			
CO3	3	1	3	3	3	-	-	-	-	-	-	2			
CO4	3	2	3	3	1	-	-	-	-	-	-	2			
CO5	3	1	3	3	2	-	-	-	-	-	-	1			
	3	High				-					2	Medium			

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

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22PARE04	Rocketry and Space Mechanics	L	T	P	C
		3	0	0	3
Nature of Course	**Professional Elective**				
Pre requisites	**Propulsion**				

Course objectives:

The course is intended to

1. To familiarize the students on fundamental aspects of rocket propulsion
2. To familiarize the students on Multi stating of rocket vehicle and spacecraft dynamics.

Course outcomes:

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Orbital Mechanics	Apply
CO2	Satellite Dynamics	Apply
CO3	Rocket Motion	Apply
CO4	Rocket Aerodynamics	Apply
CO5	Staging and Control of Rocket Vehicles	Apply

Course contents:

UNIT I Orbital Mechanics **9**

Description of solar system — Kepler"s Laws of planetary motion — Newton's Law of Universal gravitation — Two body and Three-body problems — Jacobi's Integral, Librations points - Estimation of orbital and escape velocities

UNIT II Satellite Dynamics **9**

Geosynchronous and geostationary satellites- factors determining life time of satellites – satellite perturbations – methods to calculate perturbations- Hohmann orbits – calculation of orbit parameters – Determination of satellite rectangular coordinates from orbital elements

UNIT III Rocket Motion **10**

Principle of operation of rocket motor - thrust equation – one dimensional and two dimensional rocket motions in free space and homogeneous gravitational fields – Description of vertical, inclined and gravity turn trajectories determinations of range and altitude – simple approximations to burnout velocity.

UNIT IV Rocket Aerodynamics **9**

Description of various loads experienced by a rocket passing through atmosphere – drag estimation – wave drag, skin friction drag, form drag and base pressure drag – Boat-tailing in missiles – performance at various altitudes – conical and bell shaped nozzles – adapted nozzles – rocket dispersion – launching problems.

UNIT V Staging and Control of Rocket Vehicles **8**

Need for multi-staging of rocket vehicles – multistage vehicle optimization – stage separation dynamics and separation techniques- aerodynamic and jet control methods of rocket vehicles - SITVC.

Total: 45 Periods

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References

1. E.R. Parker, “Materials for Missiles and Spacecraft”, McGraw-Hill Book Co., Inc., 1982.
2. G.P. Sutton, “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 5th Edition, 1986.
3. J.W. Cornelisse, “Rocket Propulsion and Space Dynamics”, J.W. Freeman & Co., Ltd., London, 1982
4. Van de Kamp, “Elements of Astro-mechanics”, Pitman Publishing Co., Ltd., London, 1980.

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	3	3	-	-	-	-	-	-	2			
CO2	3	2	3	1	1	-	-	-	-	-	-	2			
CO3	3	1	3	3	3	-	-	-	-	-	-	2			
CO4	3	2	3	3	1	-	-	-	-	-	-	2			
CO5	3	1	3	3	2	-	-	-	-	-	-	1			
	3	High				-					2	Medium			

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

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22PARE05	Experimental Stress Analysis	L	T	P	C
		3	0	0	3
Nature of Course	**Professional Elective**				
Pre requisites	**Strength of Materials**				

Course objectives:

The course is intended to

1. To make the students learn basic principles of operation, electrical resistance strain gauges, photoelasticity and
2. To make the students learn interferometric techniques and non destructive methods

Course outcomes:

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Orbital Mechanics	Apply
CO2	Satellite Dynamics	Apply
CO3	Rocket Motion	Apply
CO4	Rocket Aerodynamics	Apply
CO5	Staging and Control of Rocket Vehicles	Apply

Course contents:

UNIT I Introduction **8**

Principle of measurements-Accuracy, sensitivity and range- Mechanical, Optical, Acoustical and Electrical extensometers.

UNIT II Electrical Resistance Strain Gauges **12**

Principle of operation and requirements-Types and their uses-Materials for strain gauge- Calibration and temperature compensation-Cross sensitivity-Rosette analysis-Wheatstone bridge-Potentiometer circuits for static and dynamic strain measurements-Strain indicators- Application of strain gauges to wind tunnel balance.

UNIT III Principles of Photoelasticity **9**

Two dimensional photo elasticity-Concepts of photoelastic effects-Photoelastic materials-Stress optic law-Plane polariscope–Circular polariscope-Transmission and Reflection type-Effect of stressed model in Plane and Circular polariscope. Interpretation of fringe pattern Isoclinics and Isochromatics.-Fringe sharpening and Fringe multiplication techniques-Compensation and separation techniques-Introduction to three dimensional photoelasticity.

UNIT IV Photoelasticity and Interferometry Techniques **9**

Fringe sharpening and Fringe multiplication techniques-Compensation and separation techniques-Calibration methods –Photo elastic materials. Introduction to three dimensional photoelasticity. Moire fringes – Laser holography – Grid methods-Stress coat

UNIT V Non Destructive Techniques **7**

Radiography- Ultrasonics- Magnetic particle inspection- Fluorescent penetrant technique-Eddy current testing– thermography– MICRO FOCUS CT scan.

Total: 45 Periods

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References

1. A.J. Durelli and V.J. Parks, “Moire Analysis of Strain”, Prentice Hall Inc., Englewood Cliffs, New Jersey, 1980.
2. G.S. Holister, “Experimental Stress Analysis, Principles and Methods”, Cambridge University Press, 1987.
3. J Prasad & CGK Nair Non-Destructive Testing and Evaluation of Material, Second Edition Paperback –ISBN-13: 978-0070707030,Amazon,2011
4. J.W. Dally and M.F. Riley, “Experimental Stress Analysis”, McGraw-Hill Book Co., New York, 1988.
5. M. Hetenyi, “Handbook of Experimental Stress Analysis”, John Wiley & Sons Inc., New York, 1980.
6. P. Fordham, “Non-Destructive Testing Techniques” Business Publications, London, 1988.
7. Srinath,L.S., Raghava,M.R., Lingaiah,K. Gargesha,G.,Pant B. and Ramachandra,K. – Experimental Stress Analysis, Tata McGraw Hill, New Delhi, 1984
8. U. C. Jindal Experimental Stress Analysis, Pearson India, ISBN: 9789332503533, 2012

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	3	3	-	-	-	-	-	-	2			
CO2	3	2	3	1	1	-	-	-	-	-	-	2			
CO3	3	1	3	3	3	-	-	-	-	-	-	2			
CO4	3	2	3	3	1	-	-	-	-	-	-	2			
CO5	3	1	3	3	2	-	-	-	-	-	-	1			
	3	High				-					2	Medium			

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

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II- SEMESTER (Elective-II & III)

22PARE11	Theory of Plates and Shells	L	T	P	C
		3	0	0	3
Nature of Course	**Professional Elective**				
Pre requisites	**Strength of materials**				

Course objectives:

The course is intended to

1. Upon completion of the course, students will get knowledge on the behaviour of plates
2. students will get knowledge on shells with different geometry under various types ofloads

Course outcomes:

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Orbital Mechanics	Apply
CO2	Satellite Dynamics	Apply
CO3	Rocket Motion	Apply
CO4	Rocket Aerodynamics	Apply
CO5	Staging and Control of Rocket Vehicles	Apply

Course contents:

UNIT I Classical Plate Theory **8**

Classical Plate Theory – Assumptions – Differential Equations – Boundary Conditions.

UNIT II Plates of Various Shapes **10**

Navier‟s Method of Solution for Simply Supported Rectangular Plates – Levy‟s Method of Solution for Rectangular Plates under Different Boundary Conditions – Circular plates.

UNIT III Eigen Value Analysis **8**

Stability and Free Vibration Analysis of Rectangular Plates with various end conditions.

UNIT IV Approximate Methods **10**

Rayleigh – Ritz, Galerkin Methods– Finite Difference Method – Application to RectangularPlates for Static, Free Vibration and Stability Analysis.

UNIT V Shells **9**

Basic Concepts of Shell Type of Structures – Membrane and Bending Theories for Circular Cylindrical Shells.

Total: 45 Periods

References:

1. Flugge, W. Stresses in Shells, Springer – Verlag, 1985.
2. Harry Kraus, „Thin Elastic Shells‟, John Wiley and Sons, 1987.
3. T.K.Varadan & K. Bhaskar, “Anályis of plates – Theory and problems”, Narosha PublishingCo., 1999.
4. Timoshenko, S.P. and Gere, J.M., Theory of Elastic Stability, McGraw Hill Book Co. 1986.
5. Timoshenko, S.P. Winowsky. S., and Kreger, Theory of Plates and Shells, McGraw Hill BookCo., 1990.

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Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	3	3	-	-	-	-	-	-	2			
CO2	3	2	3	1	1	-	-	-	-	-	-	2			
CO3	3	1	3	3	3	-	-	-	-	-	-	2			
CO4	3	2	3	3	1	-	-	-	-	-	-	2			
CO5	3	1	3	3	2	-	-	-	-	-	-	1			
	3	High				-					2	Medium			

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

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22PARE12	High Temperature Problems in Structures	L	T	P	C
		3	0	0	3
Nature of Course	**Professional Elective**				
Pre requisites	**Aircraft structures**				

Course objectives

The course is intended to
1. Upon completion of the course, students will learn the analysis of bar,
2. Students will learn the plane truss and beam under mechanical and thermal loads.

Course outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	**Temperature Equations & Aerodynamic Heating**	Apply
CO2	Thermal Stress Analysis	Apply
CO3	Thermal Stress in Beams, Trusses And Thin Cylinders	Apply
CO4	Thermal Stresses in Plates	Apply
CO5	Special Topics & Materials	Apply

Course contents:

UNIT I Temperature Equations & Aerodynamic Heating **9**

Basics of conduction, radiation and convection — Fourier's equation — Boundary and initial conditions – One-dimensional problem formulations – Methods and Solutions. Heat balance equation for idealised structures – Adiabatic temperature – Variations – Evaluation of transient temperature.

UNIT II Thermal Stress Analysis **9**

Thermal stresses and strains – Equations of equilibrium – Boundary conditions – Thermoelasticity – Two dimensional problems and solutions – Airy stress function and applications.

UNIT III Thermal Stress in Beams, Trusses And Thin Cylinders **9**

Analysis of bar, plane truss and beam under mechanical loads and temperature. Thermal stress analysis of thin cylinder.

UNIT IV Thermal Stresses in Plates **9**

Membrane thermal stresses –Rectangular plates – Circular plates – Thick plates with temperature varying along thickness.

UNIT V Special Topics & Materials **9**

Thermal bucking – Analysis including material properties variation with temperature.

Total: 45 Periods

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References

1. A.B. Bruno and H.W. Jerome, “Theory of Thermal Stresses”, John Wiley & Sons Inc.,New York, 1980.
2. D.J. Johns, “Thermal Stress Analysis”, Pergamon Press, Oxford, 1985.
3. N.J. Hoff, “High Temperature effects in Aircraft Structures”, John Wiley & Sons Inc.,London, 1986.

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	3	3	-	-	-	-	-	-	2			
CO2	3	2	3	1	1	-	-	-	-	-	-	2			
CO3	3	1	3	3	3	-	-	-	-	-	-	2			
CO4	3	2	3	3	1	-	-	-	-	-	-	2			
CO5	3	1	3	3	2	-	-	-	-	-	-	1			
	3	High				-					2	Medium			

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

CHAIRMAN - BOARD OF STUDIES

22PARE13	Fatigue and Fracture Mechanics	L	T	P	C
		3	0	0	3
Nature of Course	**Professional Elective**				
Pre requisites	**Mechanics of machines**				

Course objectives:

The course is intended to

1. To make the students learn about fundamentals of fatigue & fracture mechanics
2. Students learn about statistical aspects of fatigue behaviour & fatigue design and testing of aerospace structures.

Course outcomes:

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Fatigue Of Structures	Apply
CO2	Statistical aspects of Fatigue Behaviour	Apply
CO3	Physical aspects of Fatigue	Apply
CO4	Fracture Mechanics	Apply
CO5	Fatigue Design and Testing	Apply

Course contents:

UNIT I Fatigue Of Structures **10**

S.N. curves – Endurance limit – Effect of mean stress – Goodman, Gerber and Soderberg relations and diagrams — Notches and stress concentrations — Neuber's stress concentration factors – plastic stress concentration factors – Notched S-N curves.

UNIT II Statistical aspects of Fatigue Behaviour **8**

Low cycle and high cycle fatigue – Coffin-Manson‟s relation – Transition life – Cyclic Strain hardening and softening – Analysis of load histories – Cycle counting techniques – Cumulative damage – Miner‟s theory – other theories.

UNIT III Physical aspects of Fatigue **5**

Phase in fatigue life – Crack initiation – Crack growth – Final fracture – Dislocations – Fatigue fracture surfaces.

UNIT IV Fracture Mechanics **15**

Strength of cracked bodies – potential energy and surface energy – Griffith‟s theory – Irwin – Orwin extension of Griffith‟s theory to ductile materials – Stress analysis of cracked bodies – Effect of thickness on fracture toughness – Stress intensity factors for typical geometries.

UNIT V Fatigue Design and Testing **7**

Safe life and fail safe design philosophies – Importance of Fracture Mechanics in aerospace structure – Application to composite materials and structures.

Total: 45 Periods

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References:

1. C.G.Sih, “Mechanics of Fracture”, Vol.1 Sijthoff and Noordhoff International Publishing Co., Netherland, 1989.
2. D.Brock, “Elementary Engineering Fracture Mechanics”, Noordhoff International Publishing Co., London, 1994.
3. J.F.Knott, “Fundamentals of Fracture Mechanics”, Butterworth & Co., (Publishers) Ltd., London, 1983.
4. W.Barrois and L.Ripley, “Fatigue of Aircraft Structures”, Pergamon Press, Oxford, 1983.

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	3	3	-	-	-	-	-	-	2			
CO2	3	2	3	1	1	-	-	-	-	-	-	2			
CO3	3	1	3	3	3	-	-	-	-	-	-	2			
CO4	3	2	3	3	1	-	-	-	-	-	-	2			
CO5	3	1	3	3	2	-	-	-	-	-	-	1			
	3	High				-					2	Medium			

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

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22PARE14	Industrial Aerodynamics	L	T	P	C
		3	0	0	3
Nature of Course	**Professional Elective**				
Pre requisites	**Aerodynamics**				

Course objectives:

The course is intended to
1. Upon completion of the course, students will learn about non-aeronautical uses of aerodynamics such as road vehicle, building aerodynamics
2. Students will learn about problems of flow induced vibrations.

Course outcomes:
On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Fatigue Of Structures	Apply
CO2	Statistical aspects of Fatigue Behaviour	Apply
CO3	Physical aspects of Fatigue	Apply
CO4	Fracture Mechanics	Apply
CO5	Fatigue Design and Testing	Apply

Course contents:

UNIT I Atmosphere **9**

Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows.

UNIT II Wind Energy Collectors **9**

Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory.

UNIT III Vehicle Aerodynamics **9**

Power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of trains and Hovercraft.

UNIT IV Building Aerodynamics **9**

Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, Building codes, Building ventilation and architectural aerodynamics.

UNIT V Flow Induced Vibrations **9**

Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter.

Total: 45 Periods

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References

1. M.Sovran (Ed), “Aerodynamics and drag mechanisms of bluff bodies and roadvehicles”, Plenum press, New York, 1978.
2. N.G. Calvent, “Wind Power Principles”, Charles Griffin & Co., London, 1979.
3. P. Sachs, “Winds forces in engineering”, Pergamon Press, 1978.
4. R.D. Blevins, “Flow induced vibrations”, Van Nostrand, 1990.

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	3	3	-	-	-	-	-	-	2			
CO2	3	2	3	1	1	-	-	-	-	-	-	2			
CO3	3	1	3	3	3	-	-	-	-	-	-	2			
CO4	3	2	3	3	1	-	-	-	-	-	-	2			
CO5	3	1	3	3	2	-	-	-	-	-	-	1			
	3	High				-					2	Medium			

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

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22PARE15	Hypersonic Aerodynamics	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Aerodynamics				

Course objectives:

The course is intended to

1. To make students learn the peculiar hypersonic speed flow characteristics pertaining to flight vehicles
2. The approximate solution methods for hypersonic flows.
3. The objective is also to impart knowledge on hypersonic viscous interactions and theireffect on aerodynamic heating.

Course outcomes:

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Basics of Hypersonic Aerodynamics	Apply
CO2	Surface Inclination Methods for Hypersonic inviscid Flows	Apply
CO3	Approximate Methods for Inviscid Hypersonic Flows`	Apply
CO4	Viscous Hypersonic Flow Theory	Apply
CO5	Viscous Interactions in Hypersonic Flows	Apply

Course contents:

UNIT I Basics of Hypersonic Aerodynamics **8**

Thin shock layers – entropy layers – low density and high density flows – hypersonic flight paths hypersonic flight similarity parameters – shock wave and expansion wave relations of inviscid hypersonic flows.

UNIT II Surface Inclination Methods for Hypersonic inviscid Flows **9**

Local surface inclination methods – modified Newtonian Law – Newtonian theory – tangent wedge or tangent cone and shock expansion methods – Calculation of surface flow properties

UNIT III Approximate Methods for Inviscid Hypersonic Flows` **9**

Approximate methods hypersonic small disturbance equation and theory – thin shock layer theory – blast wave theory - entropy effects - rotational method of characteristics - hypersonic shock wave shapes and correlations.

UNIT IV Viscous Hypersonic Flow Theory **10**

Navier–Stokes equations – boundary layer equations for hypersonic flow – hypersonic boundary layer – hypersonic boundary layer theory and non similar hypersonic boundary layers – hypersonic aerodynamic heating and entropy layers effects on aerodynamic heating – heat flux estimation.

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UNIT V Viscous Interactions in Hypersonic Flows **9**

Strong and weak viscous interactions – hypersonic shockwaves and boundary layer interactions – Estimation of hypersonic boundary layer transition- Role of similarity parameter for laminar viscous interactions in hypersonic viscous flow.

Total: 45 Periods

References

1. John D. Anderson, Jr, Hypersonic and High Temperature Gas Dynamics, McGraw-HillSeries, New York, 1996.
2. John T. Bertin, Hypersonic Aerothermodynamics, 1994 AIAA Inc., Washington D.
3. John.D.Anderson, Jr., Modern Compressible Flow with Historical perspectiveHypersonic Series.
4. William H. Heiser and David T. Pratt, Hypersonic Air Breathing propulsion, AIAAEducation Series.

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	3	3	-	-	-	-	-	-	2			
CO2	3	2	3	1	1	-	-	-	-	-	-	2			
CO3	3	1	3	3	3	-	-	-	-	-	-	2			
CO4	3	2	3	3	1	-	-	-	-	-	-	2			
CO5	3	1	3	3	2	-	-	-	-	-	-	1			
	3	High				-					2	Medium			

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

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22PARE16	Computational Heat Transfer	L	T	P	C
		3	0	0	3
Nature of Course	**Professional Elective**				
Pre requisites	**Computational fluid dynamics**				

Course objectives:

The course is intended to

1. To make the students learn to solve conductive, transient conductive, convective problems
2. Students learn to solve radiative heat transfer problems using computational methods.

Course outcomes:

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Solution to algebraic equation-Direct Method and Indirect Method-Types of boundary condition.	Apply
CO2	Conductive Heat Transfer	Apply
CO3	Transient Heat Conduction	Apply
CO4	Convective Heat Transfer	Apply
CO5	Radiative Heat Transfer	Apply

Course contents:

UNIT I Introduction **9**

Finite Difference Method-Introduction-Taylor‟s series expansion - Discretisation Methods Forward, backward and central differencing scheme for Ist order and second order Derivatives — Types of partial differential equations-Types of errors. Solution to algebraic equation-Direct Method and Indirect Method-Types of boundary condition. FDM - FEM - FVM.

UNIT II Conductive Heat Transfer **9**

General 3D-heat conduction equation in Cartesian, cylindrical and spherical coordinates. Computation (FDM) of One – dimensional steady state heat conduction –with Heat generation-without Heat generation- 2D-heat conduction problem with different boundary conditions- Numerical treatment for extended surfaces. Numerical treatment for 3D- Heat conduction.Numerical treatment to 1D-steady heat conduction using FEM.

UNIT III Transient Heat Conduction **9**

Introduction to Implicit, explicit Schemes and crank-Nicolson Schemes Computation(FDM) of One –dimensional un-steady heat conduction –with heat Generation-without Heat generation - 2D-transient heat conduction problem with different boundary conditions using Implicit, explicit Schemes. Importance of Courant number. Analysis for I-D,2-D transient heat Conduction problems.

UNIT IV Convective Heat Transfer **9**

Convection- Numerical treatment(FDM) of steady and unsteady 1-D and 2-d heat convection-diffusion steady-unsteady problems- Computation of thermal and Velocity boundary layer flows. Upwind scheme. Stream function-vorticity approach-Creeping flow

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UNIT V Radiative Heat Transfer **9**

Radiation fundamentals-Shape factor calculation-Radiosity method- Absorption Method- Montacalro method-Introduction to Finite Volume Method- Numerical treatment of radiation enclosures using finite Volume method. Developing a numerical code for 1D, 2D heat transfer problems.

Total: 45 Periods

References

1. C.Y.Chow, "Introduction to Computational Fluid Dynamics", John Wiley.
2. J.P. Holman, "Heat Transfer", McGraw-Hill Book Co., Inc., New York, 6th Edition, 1991.
3. John D. Anderson, JR" Computational Fluid Dynamics", McGraw-Hill Book Co., Inc., New York, 1995.
4. John H. Lienhard, "A Heat Transfer Text Book", Prentice Hall Inc., 1981.
5. Pletcher and Tennahils " Computational Heat Trasnfer"…..
6. T.J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2002
7. Yunus A. Cengel, Heat Transfer – A Practical Approach Tata McGraw Hill Edition, 2003.

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	3	3	-	-	-	-	-	-	2			
CO2	3	2	3	1	1	-	-	-	-	-	-	2			
CO3	3	1	3	3	3	-	-	-	-	-	-	2			
CO4	3	2	3	3	1	-	-	-	-	-	-	2			
CO5	3	1	3	3	2	-	-	-	-	-	-	1			
	3	High				-					2	Medium			

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

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22PARE18	Advanced Composite Materials and Structures	L	T	P	C
		3	0	0	3
Nature of Course	**Professional Elective**				
Pre requisites	**Composite Materials and Structures**				

Course objectives:

The course is intended to

1. To impart knowledge to the students on the macro mechanics of composite materials, analysis
2. To impart knowledge of manufacturing methods of composite materials and introduce failure theories of composites.

Course outcomes:

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	To learn the Application of composite to aircraft structures	Apply
CO2	Apply the knowledge to design of composite materials & structures.	Apply
CO3	Analysis of Laminated Composites	Apply
CO4	To explore the fabrication of fiber	Apply
CO5	To Learn the failure theory and sandwich composite	Apply

Course contents:

Unit I Introduction **10**

Classification and characteristics of composite materials - Types of fiber and resin materials, functions and their properties – Application of composite to aircraft structures-Micromechanics Mechanics of materials, Elasticity approaches-Mass and volume fraction of fibers and resins-Effect of voids, Effect of temperature and moisture.

Unit II Macromechanics **10**

Hooke's law for orthotropic and anisotropic materials-Lamina stress-strain relations referred to natural axes and arbitrary axes.

Unit III Analysis of Laminated Composites **10**

Governing equations for anisotropic and orthotropic plates- Angle-ply and cross ply laminatesAnalysis for simpler cases of composite plates and beams - Interlaminar stresses-Netting analysis.

Unit IV Manufacturing & Fabrication Processes **8**

Manufacture of glass, boron and carbon fibers-Manufacture of FRP components- Open mould and closed mould processes. Properties and functions of resins.

Unit V Failure Theory and NDE **7**

Failure criteria-Flexural rigidity of Sandwich beams and plates – composite repair- Ultra Sonic Technique - AE technique.

Total: 45 Periods

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References

1. Autar K. Kaw, Mechanics of Composite Materials, CRC Press LLC, 1997
2. B.D. Agarwal and L.J. Broutman, “Analysis and Performance of fiber composites”, John-Wiley and Sons, 1990
3. G.Lubin, “Hand Book on Fibre glass and advanced plastic composites”, Van Nostrand Co., New York, 1989.
4. J Prasad & CGK Nair Non-Destructive Testing and Evaluation of Material, Second Edition Paperback –ISBN-13: 978-0070707030,Amazon,2011
5. L.R. Calcote, “Analysis of laminated structures”, Van Nostrand Reinhold Co.,1989.
6. Michael Chun-Yung Niu Composite Airframe Structures Third Edition Conmilit Publishers 1997
7. P. Fordham, “Non-Destructive Testing Techniques” Business Publications, London, 1988.
8. R.M. Jones, “Mechanics of Composite Materials”, 2nd Edition, Taylor & Francis, 1999

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	3	3	-	-	-	-	-	-	2			
CO2	3	2	3	1	1	-	-	-	-	-	-	2			
CO3	3	1	3	3	3	-	-	-	-	-	-	2			
CO4	3	2	3	3	1	-	-	-	-	-	-	2			
CO5	3	1	3	3	2	-	-	-	-	-	-	1			
	3	High				-					2	Medium			

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

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22PARE17	Wind Power Engineering	L	T	P	C
		3	0	0	3
Nature of Course	**Professional Elective**				
Pre requisites	**Aerodynamics, Flight dynamics**				

Course objectives:

The course is intended to

1. Upon completion of the course, students will learn about aerodynamics
2. Students will learn about design and control of wind turbines.

Course outcomes:

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Wind Energy Power characteristics	Apply
CO2	Wind Characteristics and Resources	Apply
CO3	Aerodynamics of Wind Turbines	Apply
CO4	Wind Turbine Design & Control	Apply
CO5	Environmental and Site Aspects	Apply

Course contents:

UNIT I Introduction to Wind Energy **8**

Background,Motivations, and Constraints, Historical perspective, Modern Components, wind turbines geometry and Power characteristics.

UNIT II Wind Characteristics and Resources **8**

General characteristics of the wind resource, Atmospheric boundarylayer characteristics, Wind data analysis and resource estimation, Wind turbine energy production estimates using statistical techniques

UNIT III Aerodynamics of Wind Turbines **12**

Overview , 1-D Momentum theory,Ideal horizontal axis wind turbine with wake rotation, Airfoils and aerodynamic concepts -Momentum theory and blade element theory General rotor blade shape performance prediction - Wind turbine rotor dynamics

UNIT IV Wind Turbine Design & Control **9**

Brief design overview – Introduction -Wind turbine control systems -Typical grid-connected turbine operation -Basic concepts of electricpower- Power transformers -Electrical machines

UNIT V Environmental and Site Aspects **8**

Overview- Wind turbine siting - Installation and operation- Wind farms- Overview of wind energy economics-Electromagnetic interference-noise-Land use impacts - Safety

Total: 45 Periods

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References

1. Emil Simiu & Robert H Scanlan, Wind effects on structures - fundamentals and applications to design, John Wiley & Sons Inc New York, 1996.
2. IS: 875 (1987) Part III Wind loads, Indian Standards for Building codes.
3. N J Cook, Design Guides to wind loading of buildings structures Part I & II,Butterworths, London, 1985
4. Tom Lawson Building Aerodynamics Imperial College Press London, 2001

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	3	3	-	-	-	-	-	-	2			
CO2	3	2	3	1	1	-	-	-	-	-	-	2			
CO3	3	1	3	3	3	-	-	-	-	-	-	2			
CO4	3	2	3	3	1	-	-	-	-	-	-	2			
CO5	3	1	3	3	2	-	-	-	-	-	-	1			
	3	High				-					2	Medium			

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

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