M.E. Aeronautical Engineering

Curriculum & syllabus

R 2020

Excel

ENGINEERING COLLEGE

(Autonomous)

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

KOMARAPALAYAM – 637303

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DEPARTMENT OF AERONAUTICAL ENGINEERING
M.E. AERONAUTICAL ENGINEERING
REGULATION 2020
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)									
20PMA101	Advanced Mathematical Methods	FC	3	2	0	4	40	60	100
20PAR101	Advanced Propulsion System	PC	3	0	0	3	40	60	100
20PAR102	Theory of Vibrations	PC	3	0	0	3	40	60	100
20PAREXX	Professional Elective – I	PE	3	0	0	3	40	60	100
Theory with Practical Course(s)									
20PAR103	Advanced Aerodynamics	PC	3	0	2	4	50	50	100
20PAR104	Advanced Structural Mechanics	PC	3	0	2	4	50	50	100
Employability Enhancement Course									
20PAR105	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)									
20PAR201	Advanced UAV Design	PC	3	0	0	3	40	60	100
20PAR202	Aircraft Flight Dynamics	PC	3	0	0	3	40	60	100
20PAREXX	Professional Elective – II	PE	3	0	0	3	40	60	100
20PAREXX	Professional Elective – III	PE	3	0	0	3	40	60	100
Theory with Practical Course(s)									
20PAR203	Finite Element Method for Aircraft structure Design	PC	3	0	2	4	50	50	100
20PAR204	Computational Fluid Dynamics for Aerodynamics	PC	3	0	2	4	50	50	100
Employability Enhancement Course									
20PAR205	Technical Presentation Seminar	MC	0	0	2	1	100	0	100
Total			18	0	6	21	360	340	700

CHAIRMAN - BOARD OF STUDIES

LIST OF PROFESSIONAL ELECTIVES									
Code No.	Course	Category	Periods / Week			Credits	Maximum Marks		
			L	T	P		CA	FE	Total
I – SEMESTER (Elective-I)									
20PARE01	Boundary Layer Theory	PE	3	0	0	3	40	60	100
20PARE02	Aircraft Design	PE	3	0	0	3	40	60	100
20PARE03	Theory of Elasticity	PE	3	0	0	3	40	60	100
20PARE04	Rocketry and Space Mechanics	PE	3	0	0	3	40	60	100
20PARE05	Experimental Stress Analysis	PE	3	0	0	3	40	60	100
II- SEMESTER (Elective-II & III)									
20PARE11	Theory of Plates and Shells	PE	3	0	0	3	40	60	100
20PARE12	High Temperature Problems in Structures	PE	3	0	0	3	40	60	100
20PARE13	Fatigue and Fracture Mechanics	PE	3	0	0	3	40	60	100
20PARE14	Industrial Aerodynamics	PE	3	0	0	3	40	60	100
20PARE15	Hypersonic Aerodynamics	PE	3	0	0	3	40	60	100
20PARE16	Computational Heat Transfer	PE	3	0	0	3	40	60	100
20PARE17	Wind Power Engineering	PE	3	0	0	3	40	60	100
III- SEMESTER (Elective-IV & V)									
20PARE21	Aero Elasticity	PE	3	0	0	3	40	60	100
20PARE22	Design and Analysis of Turbomachines	PE	3	0	0	3	40	60	100
20PARE23	Helicopter Aerodynamics	PE	3	0	0	3	40	60	100
20PARE24	Experimental Aerodynamics	PE	3	0	0	3	40	60	100
20PARE25	High Temperature Gas Dynamics	PE	3	0	0	3	40	60	100
20PARE26	High Speed Jet Flows	PE	3	0	0	3	40	60	100
20PARE27	Combustion in Jet and Rocket Engines	PE	3	0	0	3	40	60	100
20PARE28	Propeller Aerodynamics	PE	3	0	0	3	40	60	100
20PARE29	Aircraft Guidance and Control	PE	3	0	0	3	40	60	100
20PARE30	Avionics	PE	3	0	0	3	40	60	100
20PARE31	Wind Tunnel Techniques	PE	3	0	0	3	40	60	100

CHAIRMAN-BOARD OF STUDIES

III- SEMESTER									
Code No.	Course	Category	Periods / Week			Credits	Maximum Marks		
			L	T	P		CA	FE	Total
Theory Course(s)									
20PEE301	Research Methodology and Intellectual Property Rights	PC	3	0	0	3	40	60	100
20PAREXX	Professional Elective –IV	PE	3	0	0	3	40	60	100
20PAREXX	Professional Elective- V	PE	3	0	0	3	40	60	100
Employability Enhancement Course									
20PAR301	Project Phase – I	EEC	0	0	12	6	50	50	100
Mandatory Course									
20PAR302	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									
20PAR401	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

CHAIRMAN-BOARD OF STUDIES

20PMA101	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 inital value, initial–boundary value and boundary value problems in Partial Differential Equations	Apply
CO2	Maximizing and minimizing the functional that occur in various branches ofEngineering 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 — Bessels 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 Poissons 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

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 Hall of 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 Snicer, 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	

20PAR101	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 Propellar	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 Gasturbine 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.

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

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,1999
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			

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

20PAR102	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 frecuency 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, DAlembert'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 vectors and 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

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.E. 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				

20PAR103	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

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 camberod aerofoil section
8. Flow visualization studies in incompressible flows
9. Calibration of supersonic wind tunne
10. Supersonic flow visualization studies

Total: 30 Periods

References

1. E.L. Houghton and N.B. Carruthers, 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, 1962.
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.

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						

CHAIRMAN-BOARD OF STUDIES

20PAR104	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.

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. Timoshenko & S.woinowsky Krieger, Theory of Plates and Shells, 2nd Edition. McGraw-Hill, Singapore, 1990.

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						

CHAIRMAN - BOARD OF STUDIES

20PAR105	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

CHAIRMAN-BOARD OF STUDIES

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

20PAR201	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 Decision/Viewing, Supporting Databases.

Total: 45 Periods

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 Road to 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	2	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				

CHAIRMAN, BOARD OF STUDIES

20PAR202	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 and its limitations	Analyze
CO3	Illustrate the degrees of freedom and static longitudinal stability attained in aircraft.	Apply
CO4	Correlate the aircrafts 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.

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 Cormick, 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 & Sons, 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, 1986.
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				

20PAR203	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 engineering problems 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 familianze 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.

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, 1999
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

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						

CHAIRMAN - BOARD OF STUDIES

20PAR204	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 vortex and source panel methods for lifting and non lifting cases respectively

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. Smolderr "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			

CHAIRMAN- BOARD OF STUDIES

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						

20PAR205	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

CHAIRMAN - BOARD OF STUDIES

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			

20PEE301	Research Methodology and Intellectual Property Rights (Common to all Branches of M.E., / M.Tech., Programme)	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Basic Research Knowledge				

Course Objectives

1. To learn the basics of research problems, effective technical writing and developing a research proposal.
2. To study about Nature of Intellectual Property and Patent Rights.

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Examine research problem formulation.	Apply
CO2	Analyze research related information.	Analyze
CO3	Follow research ethics.	Apply
CO4	Utilize the Patent information and databases	Apply
CO5	Emphasis the need of information about Intellectual Property Right to be promoted among students in general and engineering in particular	Analyze

Course Contents:

Unit I Basics of Research Problem 9

Meaning of research problem – Sources of research problem Criteria Characteristics of a good research problem – Errors in selecting a research problem – Scope and objectives of research problem, Approaches of investigation of solutions for research problem – Data collection – Analysis – Interpretation – Necessary instrumentations

Unit II Technical Writing and Proposal

9

Effective literature studies approaches – Analysis Plagiarism – Research ethics – Effective technical writing – How to write Report – Paper – Developing Research Proposal – Format of research proposal – Presentation and Assessment by a review committee

Unit III Intellectual Property

9

Nature of Intellectual Property: Patents – Designs –Trade and Copyright. Process of Patenting and Development: Technological research – Innovation – Patenting – Development. International Scenario: International cooperation on Intellectual Property – Procedure for grants of patents Patenting under PCT.

Unit IV Patent Rights

9

Patent Rights: Scope of Patent Rights – Licensing and transfer of technology – Patent information and databases – Geographical Indications

Unit V Developments in IPR

9

New Developments in IPR: Administration of Patent System – New developments in IPR – IPR of Biological Systems – Computer Software – Traditional knowledge Case Studies – IPR and IITs.

Total: 45 Periods

Reference

1. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
2. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners",

2014.
3. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007
5. Wayne Goddard and Stuart Melville, "Research Methodology. An Introduction", Juta and Company Ltd, 2nd Edition 2004.
6. Wayne Goddard and Stuart Melville "Research Methodology. An Introduction", 2004.
7. Stuart Melville and Wayne Goddard. "Research methodology: an introduction for science & engineering students", 1996.
8. Stuart Melville and Wayne Goddard, 'Research methodology: anintroduction for science & engineering students", Juta and Company Ltd, 1996.

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

CHAIRMAN-BOARD OF STUDIES

20PAR301	PROJECT WORK PHASE - I	L	T	P	C
		0	0	12	6
Nature of course	Employability Enhancement Course				
Pre requisites	Concepts of Research Methodology				

Course Objectives

The course is intended to

1. Identify a specific problem for the current structural needs of the society.
2. Collect information related to the same through detailed review of literature.
3. Develop the methodology to solve the identified problem
4. Review the methodology and comparing its merits and demerits.
5. Experimental work related to the methodology which includes basic concepts , basic tests etc.,

Course Outcomes

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

CO. No	Course Outcome	Bloom's Level
CO 1	Identify and formulate research problem	Apply
CO 2	Concentrate on literatures related to research problem.	Understand
CO 3	Possess the ability to write a standard technical paper and presentation.	Apply
CO 4	Find the correct procedure for applying patents	Apply
CO 5	Become well versed on patent rights, licensing and transfer of technology.	Understand

Course Contents

The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

Total : 180 Periods

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	3	3	3	3	3	3	3	3	3	3			
CO 2	3	3	3	3	3	3	3	3	3	3	3	3			
CO 3	3	3	3	3	3	3	3	3	3	3	3	3			
CO 4	3	3	3	3	3	3	3	3	3	3	3	3			
CO 5	3	3	3	3	3	3	3	3	3	3	3	3			
	3	High				2	Medium					1	Low		

	Continuous Assessment (50 marks)						Final Viva Voce Examination (50 marks)
	Review I (10)	Review II (10)	Review III (10)	Publication (10)	Report (10 Marks)	Total (50)	
Marks	100	100	100	10	10	50	50

CHAIRMAN BOARD OF STUDIES

20PAE401	PROJECT WORK PHASE - II	L	T	P	C
		0	0	24	12
Nature of course	Employability Enhancement Course				
Pre requisites	Knowledge in Electronics Engineering				

Course Objectives

The course is intended to

1 Solve the identified problem based on the formulated methodology
2 Develop skills to analyze the problem related to area.
3 Continue the trials until the expected positive results are obtained
4 Preparation of preliminary report and discussion on test results
5 Arrive at conclusion and suggestion for future works.

Course Outcomes

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

CO. No	Course Outcome	Bloom's Level
CO 1	Select different software/ computational/analytical tools.	Apply
CO 2	Design and develop an experimental set up/ equipment/test rig.	Creating
CO 3	Conduct tests on existing setup with equipments and draw logical results.	Analyzing
CO 4	Conclude the results with suitable remarks and suggestion for further extension of work.	Evaluating
CO 5	Present their topic of study to the engineering community.	Apply

Course Contents

The student should continue the phase I work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report and the viva-voce examination by a panel of examiners including one external examiner.

Total : 360 Periods

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	3	3	3	3	3	3	3	3	3	3			
CO 2	3	3	3	3	3	3	3	3	3	3	3	3			
CO 3	3	3	3	3	3	3	3	3	3	3	3	3			
CO 4	3	3	3	3	3	3	3	3	3	3	3	3			
CO 5	3	3	3	3	3	3	3	3	3	3	3	3			
	3	High				2	Medium					1	Low		

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

CHAIRMAN - BOARD OF STUDIES

I – SEMESTER (Elective-I)

20PARE01	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 – Pohlhausen 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

References

1. A.J. Reynolds "Turbulent flows in Engineering", John Wiley & Sons, 1960.
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				

CHAIRMAN - BOARD OF STUDIES

20PARE02	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 manoeuvorability 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

References

1. A.A. Lebedenskl. "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., 1960.
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				

CHAIRMAN-BOARD OF STUDIES

20PARE03	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 Duncer's table. - Ax symmetric problems - Bending of Curved Bars - Circular Discs and Cylinders – Rotating Discs and Cylinders Kirsch, Boussinasqun's and Michell's problems

UNIT V Torsion 8

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

Total: 45 Periods

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				

CHAIRMAN-BOARD OF STUDIES

20PARE04	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 staging 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 — Jacobis 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

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, 5"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				

CHAIRMAN - BOARD OF STUDIES

20PARE05	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

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, 1968.
5. M. Hetenyi, "Handbook of Experimental Stress Analysis", John Wiley & Sons Inc., New York, 1960
6. P. Fordham, "Non-Destructive Testing Techniques" Business Publications, London, 1968.
7. Srinath,L.S., Raghava,M.R., Lingaiah,K. Gargesha,C.,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				

CHAIRMAN – BOARD OF STUDIES

II- SEMESTER (Elective-II & III)

20PARE11	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 of loads

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 Rectangular Plates 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, "Analysis of plates – Theory and problems', Narosha Publishing Co., 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 Book Co., 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				

CHAIRMAN-BOARD OF STUDIES

20PARE12	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 — Fouriers 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 buckling Analysis including material properties variation with temperature.

Total: 45 Periods

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, "I ligh 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

20PARE13	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 Neubers stress concentration factors – plastic stress concentration factors – Notched S-N curves.

UNIT II Statistical aspects of Fatigue Behaviour **6**

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**

Phases 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

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				

CHAIRMAN BOARD OF STUDIES

20PARE14	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 aerocynamics 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

References

1. M.Sovran (Ed), "Aerodynamics and drag mechanisms of bluff bodies and road vehicles", 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	-	-	-	-	-	-	2			
	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

20PARE15	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 their effect 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.

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				

CHAIRMAN - BOARD OF STUDIES

20PARE16	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 us ng 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 1st 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

Genera 3D-heat conduction equation in Cartesian, cylindrical and spherical coordinates. Computation (FDM) of One – dimensional steady state heat conduction –with Heal generation-without Heat generation- 2D-heat conduction problem with different boundary conditions- Numerica treatment for extended surfaces. Numerical treatmen; for 3D- Heat conduction.Numerica. 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 Implicat, explicit Schemes. Importance of Courant number. Analysis for 1-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

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 Aoproach Tata McGraw Hil 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				

CHAIRMAN BOARD OF STUDIES

20PARE17	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

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				

CHAIRMAN-BOARD OF STUDIES

III- SEMESTER (Elective-IV & V)

20PARE21	Aero Elasticity	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. To make the students understand aero elastic phenomena, flutter and to make them solve steady state aero elastic problems
2. Students can understand the theoretical concepts of material behaviour with particular emphasis on their elasticity property.

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	To understand the aeroelastic phenomena	Apply
CO2	Ability to analysis strip theory and numerical approximations	Apply
CO3	To understand the aeroelastic problems	Apply
CO4	Ability to known flutter analysis	Apply
CO5	To Evaluate the aeroelastic problems	Apply

Course contents:

UNIT I Aeroelastic Phenomena 6

Stability versus response problems – The aero-elastic triangle of forces – Aeroelasticity in Aircraft Design – Prevention of aeroelastic instabilities. Influence and stiffness co-efficient, Flexure – torsional oscillations of beam – Differential equation of motion of beam

UNIT II Divergence of a Lifting Surface 10

Simple two dimensional idealisations-Strip theory – Integral equation of the second kind – Exact solutions for simple rectangular wings – 'Semirigid' assumption and approximate solutions – Generalised coordinates – Successive approximations – Numerical approximations using matrix equations

UNIT III Steady State Aerolastic Problems 9

Loss and reversal of aileron control – Critical aileron reversal speed – Aileron efficiency – Semi rigid theory and successive approximations – Lift distribution – Rigid and elastic wings. Tail efficiency. Effect of elastic deformation on static longitudinal stability

UNIT IV Flutter Phenomenon 14

Non-dimensional parameters – Stiffness criteria – Dynamic mass balancing – Dimensional similarity. Flutter analysis – Two dimensional thin airfoils in steady incompressible flow – Quasisteady aerodynamic derivatives. Galerkin method for critical flutter speed – Stability of disturbed motion – Solution of the flutter determinant – Methods of determining the critical flutter speeds – Flutter prevention and control

UNIT V Examples of Aeroelastic Problems 6

Galloping of transmission lines and Flow induced vibrations of transmission lines, tall slender structures and suspension
bridges, VIV

Total: 45 Periods

References

1. Y C. Fung, "An Introduction to the Theory of Aeroelasticity", John Wiley & Sons Inc., New York, 2008.
2. R.D.Blevins, "Flow Induced Vibrations", Krieger Pub Co., 2001
3. R.L. Bisplinghoff, H.Ashley, and R.L. Halfmann, "Aeroelasticity", II Edition Addison Wesley Publishing Co., Inc., 1996.
4. E G. Broadbent, "Elementary Theory of Aeroelasticity", Sun Hill Publications Ltd., 1986.
5. R.H Scanlan and R Rosenbaum, "Introduction to the study of Aircraft Vibration and Flutter", Macmillan Co., New York, 1981

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

20PARE22	Design and Analysis of Turbomachines	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Mechanics of machines, Fluid Mechanics and Machinery Basic of mechanical vibrations				

Course objectives:

The course is intended to

1. To design and analyse the performance of Turbo machines for engineering applications
2. To understand the energy transfer process in Turbomachines and governing equations of various forms.
3. To understand the structural and functional aspects of major components of Turbomachines
4. To design various Turbomachines for power plant and aircraft applications

Course outcomes:

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

CO. No.	Course Outcome	Bloom's Level
CO1	Understand the design principles of the turbomachines	Apply
CO2	Analyse the turbomachines to improve and optimize its performance	Apply
CO3	To understand the design concept of combustion chamber.	Apply
CO4	Analysis the axial and radial flow turbines.	Apply
CO5	To understand the designing of gas turbine and jet engine cycles.	Apply

Course contents:

UNIT I Introduction 12

Basics of isentropic flow – static and stagnation properties – diffuser and nozzle configurations - area ratio – mass flow rate – critical properties. Energy transfer between fluid and rotor velocity triangles for a generalized turbomachines - velocity diagrams. Euler's equation for turbomachines and its different forms Degree of reaction in turbo-machines – various efficiencies – isentropic, mechanical, thermal, overall and polytrophic

UNIT II Centrifugal and Axial Flow Compressors 9

Centrifugal compressor - configuration and working – slip factor - work input factor – ideal and actual work - pressure coefficient - pressure ratio. Axial flow compressor – geometry and working - velocity diagrams – ideal and actual work – stage pressure ratio - free vortex theory – performance curves and losses

UNIT III Combustion Chamber 9

Basics of combustion, Structure and working of combustion chamber – combustion chamber arrangements - flame stability – fuel injection nozzles. Flame stabilization - cooling of combustion chamber

UNIT IV Axial and Radial Flow Turbines 9

Elementary theory of axial flow turbines stage parameters- multi staging - stage loading and flow coefficients. Degree of reaction - stage temperature and pressure ratios – single and twin spool arrangements - performance, matching of components, Blade Cooling, Radial flow turbines

UNIT V Gas Turbine and Jet Engine Cycles 9

Gas turbine cycle analysis – simple and actual Reheated, Regenerative and Intercooled cycles for

power plants, Working of Turbojet, Turbofan, Turboprop, Ramjet, Scramjet and Pulsejet Engines and cycle analysis – thrust, specific impulse, specific fuel consumption, thermal and propulsive efficiencies.

Total: 45 Periods

References

1. Ganesan V., Gas Turbines, Tata McGraw Hill, 2011
2. Khajuria P R. and Dubey S.P , Gas Turbines and Propulsive Systems, Dhanpat Rai Publications, 2003.
3. Cohen H., Rogers, G F C. and Saravanmotto H I H., Gas Turbine Theory-5th Edition, John Wiely, 2001.
4. Austin H. Chruch, Centrifugal pumps and blowers. John wiley and Sons 1980.
5. Hill P G. and Peterson C R., Mechanics and Thermodynamics of Propulsion, Addition-Wesley, 1970.
6. C sanady G.T., Theory of Turbo machines, McGraw Hill, 1964.

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	2	1	1	-	2	1	1	-	-	1	2			
CO3	3	1	1	1	-	2	1	2	-	-	1	2			
CO4	2	1	1	1	1	2	1	1	-	-	1	1			
CO5	1	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				

CHAIRMAN-BOARD OF STUDIES

20PARE23	Helicopter Aerodynamics	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Aerodynamics, Fluid mechanics and characteristics, boundary layer concept				

Course objectives:

The course is intended to

1. To impart knowledge to the students and fundamental aspects of helicopter aerodynamics, performance of helicopters, stability and control aspects and also to expose them basic and aerodynamic design aspects.
2. Students will learn about the basic ideas of evolution, performance and associated stability problems of helicopter.

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	To Understand about rotorcrafts	Apply
CO2	Apply actuator theory of helicopter aerodynamics	Apply
CO3	Evaluate the performance analysis of flight	Analysis
CO4	Understand the flight stability and control	Apply
CO5	To understand design concept of aerodynamics	Apply

Course contents:

UNIT I Introduction 7

Types of rotorcraft – autogyro, gyrodyne, helicopter. Main rotor system – articulated semi rigid, rigid rotors, Collective pitch control, and cyclic pitch control, anti torque pedals

UNIT II Helicopter Aerodynamics 12

Momentum / actuator disc theory, Blade element theory, combined blade element and momentum theory, vortex theory, rotor in hover, rotor model with cylindrical wake and constant circulation along blade, free wake model. Constant chord and ideal twist rotors, Lateral flapping, Coriolis forces, reaction torque, compressibility effects, Ground effect.

UNIT III Performance 9

Hover and vertical flight, forward level flight, Climb in forward flight, optimum speeds, Maximum level speed, rotor limits envelope – performance curves with effects of altitude

UNIT IV Stability and Control 9

Helicopter Trim. Static stability – Incidence disturbance, forward speed disturbance, angular velocity disturbance, yawing disturbance, Dynamic Stability

UNIT V Aerodynamic Design 8

Blade section design, Blade tip shapes, Drag estimation – Rear fuselage upsweep.

Total: 45 Periods

References

1. Lecture Notes on "Helicopter Technology", Department of Aerospace Engineering, IIT – Kanpur and Rotary Wing aircraft R&D center, HAL, Bangalore. 1998
2. Lalit Gupta, "Helicopter Engineering", Himalayan Books, New Delhi, 1996.
3. John Fay, "The Helicopter", Himalayan Books, New Delhi, 1995.
4. J. Seddon, "Basic Helicopter Aerodynamics", AIAA Education series, Blackwell scientific publications, U.K, 1990.
5. A. Gessow and G.C.Meyers, "Aerodynamics of the Helicopter", Macmillan and Co., New York, 1982

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	1	3	3	3	-	-	-	-	-	-	2			
CO3	3	2	3	3	1	-	-	-	-	-	-	2			
CO4	3	2	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 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

20PARE24	Experimental Aerodynamics	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Aerodynamics, Fluid mechanics and characteristics, boundary layer concept				

Course objectives

The course is intended to

1. To make the students learn basic wind tunnel measurements and flow visualization methods, flow measurement variables and data acquisition method pertaining to experiments in aerodynamics.
2. Students will learn about the measurement of flow properties in wind tunnels and their associated instrumentation.

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	To Understand about basic measurements in fluid mechanics	Apply
CO2	Apply the performance of wind tunnel measurements	Apply
CO3	To understand flow visualization and analogue	Apply
CO4	To Evaluate the performance of measurements	Analysis
CO5	To understand the uncertainty analysis	Apply

Course contents

UNIT I Basic Measurements in Fluid Mechanics 8

Objective of experimental studies – Fluid mechanics measurements – Properties of fluids – Measuring instruments – Performance terms associated with measurement systems – Direct measurements - Analogue methods – Flow visualization –Components of measuring systems – Importance of model studies - Experiments on Taylor-Proudman theorem and Ekman layer – Measurements in boundary layers -

UNIT II Wind Tunnel Measurements 8

Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels - Power losses in a wind tunnel – Instrumentation and calibration of wind tunnels – Turbulence- Wind tunnel balance – Principle and application and uses – Balance calibration.

UNIT III Flow Visualization and Analogue Methods 10

Visualization techniques – Smoke tunnel – Hele-Shaw apparatus - Interferometer – Fringe-Displacement method – Shadowgraph. - Schlieren system – Background Oriented Schlieren (BOS) System - Hydraulic analogy – Hydraulic jumps – Electrolytic tank

UNIT IV Pressure, Velocity and Temperature Measurements 10

Pitot-Static tube characteristics - Velocity measurements - Hot-wire anemometry – Constant current and Constant temperature Hot-Wire anemometer - Hot-film anemometry – Laser Doppler Velocimetry (LDV) – Particle Image Velocimetry (PIV) – Pressure Sensitive Paints - Pressure measurement techniques - Pressure transducers – Temperature measurements.

UNIT V Data Acquisition Systems and Uncertainty Analysis 9

Data acquisition and processing – Signal conditioning - Estimation of measurement errors – Uncertainty calculation - Uses of uncertainty analysis.

Total: 45 Periods

References

1. Rathakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids," CRC Press – Taylor & Francis, 2007.
2. Robert B Northrop "Introduction to Instrumentation and Measurements", Second Edition, CRC Press, Taylor & Francis, 2006.

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	1	3	1	1	-	-	-	-	-	-	2			
CO2	3	2	3	3	3	-	-	-	-	-	-	2			
CO3	3	2	3	3	1	-	-	-	-	-	-	2			
CO4	3	1	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 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

20PARE25	High Temperature Gas Dynamics	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Thermal Engineering, Propulsion, Heat and mass transfer				

Course objectives:

The course is intended to

1. To make the students learn the kinetic theory of hypersonic flows and statistical thermodynamic aspects of flows at very high temperatures and also to make them familiarize the calculations transport properties of gases high temperature.
2. Students will learn statistical thermodynamics and the transport properties of high temperature gases.

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	To Understand about basic of real and ideal gases.	Apply
CO2	To understand the statistical thermodynamics	Apply
CO3	To Analysis the Hypersonic flow	Analysis
CO4	To analysis the governing equations of high temperature gases	Analysis
CO5	To understand transport properties in high temperature gases	Apply

Course contents:

UNIT I Introduction 8

Nature of high temperature flows – Chemical effects in air – Real perfect gases – Gibb's free energy and entropy by chemical and non equilibrium – Chemically reacting mixtures and boundary layers.

UNIT II Statistical Thermodynamics 8

Introduction to statistical thermodynamics – Relevance to hypersonic flow - Microscopic description of gases – Boltzman distribution – Cartesian function

UNIT III Kinetic Theory and Hypersonic Flows 9

Chemical equilibrium calculation of equilibrium composition of high temperature air – equilibrium properties of high temperature air – collision frequency and mean free path – velocity and speed distribution functions

UNIT IV Inviscid High Temperature Flows 10

Equilibrium and non – equilibrium flows – governing equations for inviscid high temperature equilibrium flows – equilibrium normal and oblique shock wave flows – frozen and equilibrium flows – equilibrium conical and blunt body flows – governing equations for non equilibrium inviscid flows.

UNIT V Transport Properties in High Temperature Gases 10

Transport coefficients – mechanisms of diffusion – total thermal conductivity – transport characteristics for high temperature air – radiative transparent gases – radiative transfer equation for transport, absorbing and emitting and absorbing gases.

Total: 45 Periods

References

1. John D Anderson, Jr., Hypersonic and High Temperature Gas Dynamics, McGraw-Hill Series, New York, 1996.
2. John D Anderson, Jr., Modern Compressible Flow with Historical perspective, McGraw-Hill Series, New York, 1996.
3. John T. Bertin, Hypersonic Aerothermodynamics publishers - AIAA Inc., Washington, D.C.,1994.
4. T.K.Bose. High Temperature Gas Dynamics,
5. William H. Heiser and David T. Pratt, Hypersonic Air breathing propulsion, AIAA Education Series, 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				

CHAIRMAN - BOARD OF STUDIES

20PARE26	High Speed Jet Flows	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Fluid mechanics and machinery, Propulsion, Rocket and space propulsion				

Course objectives:

The course is intended to

1. To make the students learn about various jet control methods, jet acoustics aspects and free shear layer flow theory pertaining to turbulent jets with high speed
2. students will be able to understand various jet control methods, jet acoustics aspects and free shear layer flow theory pertaining to turbulent jets with high speed

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	To Understand about basic of flow properties.	Apply
CO2	To apply the compressible flow theory	Apply
CO3	To Analysis the performance of jet control	Analysis
CO4	To understand the boundary layer concept	Apply
CO5	To study the types of noise	Apply

Course contents:

UNIT I Introduction 9

Types of nozzles – over expanded and under expanded flows - Isentropic flow through nozzles– Interaction of nozzle flows over adjacent surfaces - Mach disk - Jet flow – types - Numerical problems.

UNIT II Compressible Flow Theory 9

One dimensional compressible fluid flow - flow through variable area passage – nozzles and diffusers – normal and oblique shock waves and calculation of flow and fluid properties across the shocks and expansion fans, Interaction of shocks with solid and fluid surface

UNIT III Jet Control 9

Types of jet control - single jet, multi jet, co-flow jet, parallel flow jet Subsonic jets- Mathematical treatment of jet profiles- Theory of Turbulent jets- Mean velocity and mean temperature- Turbulence characteristics of free jets- Mixing length- Experimental methods for studying jets and the Techniques used for analysis- Expansion levels of jets- Over expanded, Correctly expanded, Under expanded jets - Control of jets, Centre line decay, Mach number Profile, Iso-Mach (or iso- baric) contours, Shock cell structure in under expanded and over expanded jets, Mach discs.

UNIT IV Boundary Layer Concept 9

Boundary Layer – displacement and momentum thickness- laminar and turbulent boundary layers over flat plates – velocity distribution in turbulent flows over smooth and rough boundaries- laminar sublayer, Shock-boundary layer interactions

UNIT V Jet Acoustics 9

Introduction to Acoustic – Types of noise – Source of generation- Traveling wave solution- standing wave solution – multi-dimensional acoustics -Noise suppression techniques– applications to problems

Total: 45 Periods

References

1. Ethirajan Rathakrishnan, "Applied Gas Dynamics", John Wiley, NY, 2010.
2. Rathakrishnan E., "Gas Dynamics", Prentice Hall of India, New Delhi, 2008
3. Liepmann and Roshko, "Elements of Gas Dynamics", John Wiley, NY, 1963.

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

20PARE27	Combustion in Jet and Rocket Engines	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Thermodynamics, Propulsion, Rocket and space propulsion				

Course objectives:

The course is intended to

1. To impart knowledge to the students and basic principles of combustion, types of flames and also make them familiarize the combustion process in gas turbine, ramjet, scram jet and rocket engines
2. Students will learn about the thermodynamics, physics and chemistry of combustion.

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	To Understand about basic of thermodynamics of combustion	Apply
CO2	To understand the Fundamental laws of transport phenomena	Apply
CO3	To Analysis the Effects of chemical and physical variables on Burning	Analysis
CO4	To understand the Combustion in gas turbine chambers	Apply
CO5	To understand the chemical rocket	Apply

Course contents:

UNIT I Thermodynamics of Combustion 8

Stoichiometry – absolute enthalpy- enthalpy of formation- enthalpy of combustion- laws of thermochemistry- pressure and temperature effect on enthalpy of formation, adiabatic flame temperature, chemical and equilibrium products of combustion

UNIT II Physics and Chemistry of Combustion 9

Fundamental laws of transport phenomena, Conservations Equations Transport in Turbulent Flow, Basic Reaction Kinetics, Elementary reactions, Chain reactions, Multi step reactions, simplification of reaction mechanism, Global kinetics

UNIT III Premixed and Diffused Flames 12

One dimensional combustion wave, Laminar premixed flame, Burning velocity measurement methods, Effects of chemical and physical variables on Burning velocity, Flame extinction, Ignition, Flame stabilizations, Turbulent Premixed flame, Gaseous Jet diffusion flame, Liquid fuel combustion, Atomization, Spray Combustion, Solid fuel combustion

UNIT IV Combustion in Gas Turbine, Ramjet and Scramjet 8

Combustion in gas turbine chambers, recirculation, combustion efficiency, flame holders, subsonic combustion in ramjet, supersonic combustion in scramjet, Subsonic and supersonic combustion controlled by decision mixing and heat convection.

UNIT V Combustion in Chemical Rocket 8

Combustion in liquid propellant rockets, Combustion of solid propellants- application of laminar flame theory to the burning of homogeneous propellants, Combustion in hybrid rockets, combustion instability in rockets

Total: 45 Periods

References

1. D. P. Mishra, "Fundamentals of Combustion", Prentice Hall of India, New Delhi, 2010.
2. H. S. Mukunda, "Understanding Combustion", 2nd edition, Orient Blackswan, 2009
3. Kuo K.K "Principles of Combustion" John Wiley and Sons, 2005.
4. Warren C. Strahle, "An Introduction to Combustion", Taylor & Francis, 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	-	-	-	-	-	-	-	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

20PARE28	Propeller Aerodynamics	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Thermodynamics, Propulsion, Aerodynamics, Rocket and space propulsion				

Course objectives:

The course is intended to

1. To impart knowledge to the students and basic principles of air screw theory, momentum theory and simulation approach.
2. Students will gain knowledge on various Propeller theories and propeller simulations.

Course Outcomes

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

CO. No	Course Outcome	Bloom's Level
CO1	To Understand about air screw theory.	Apply
CO2	To understand the Ideal efficiency of a propeller	Apply
CO3	To Analysis the Effects of Blade Element Theory	Analysis
CO4	To study and understand the vortex theory	Apply
CO5	To Analysis the simulation approach of propellers	Apply

Course contents:

UNIT I Air Screw Theory 8

Introduction – Non-Dimensional Coefficients – Air screw design – development of airscrew theory. The actuator- disc theory, working states of rotor, optimum rotor, Efficiency of rotor

UNIT II Axial Momentum Theory 10

Rankine-Froude theory- The momentum Equation – Ideal efficiency of a propeller, The general momentum theory- General equations – constant circulation- approximate solution- minimum loss of energy- constant efficiency. Propeller efficiency- Energy equation – approximate solution- efficiency- numerical results

UNIT III Blade Element Theory 9

Primitive Blade Element Theory- Efficiency of the blade element Blade interface- The vortex system of a propeller- induced velocity- The airfoil characteristics- Multi plane Interference- cascade of airfoils – Airfoil characteristics in a cascade.

UNIT IV Vortex Theory 9

Propeller blades- Energy and Momentum- Propeller characteristics – The application of the Vortex theory- The effect of solidity and pitch – Approximate method of solution- Effective Aspect ratio of the blades. Propellers of highest efficiency- Minimum loss of energy- Lightly loaded Propellers- Effect of profile drag- The effect of number of blades- Application of Prandtl's Formula.

UNIT V Experimental and Simulation Approach of Propellers 9

Experimental Methods- Wind tunnel interference- Thrust and Torque distribution- Scale effect- Compressibility Effect. Basics of propeller simulations- Domain selection- Grid independency study- Turbulence model investigation

Total: 45 periods

References:

1. Durand, W.F., "Applied Aerodynamics- Volume IV", Stanford University, California, 2010.
2. "Modeling Propeller Flow-Fields Using CFD" – AIAA 2008-402
3. Seddon, J., "Basic Helicopter Aerodynamics", BSP Professional Books, Oxford London, 2005.
4. Kerwin, Justin, "lecture Notes on Hydrofoils and Propellers", Cambridge, 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 assesament			
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

20PARE29	Aircraft Guidance and Control	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Aircraft design, Air traffic control, Elements of aeronautics				

Course objectives:

The course is intended to

1. To impart knowledge to the students and basic principles of aircraft guidance and control
2. Students will learn about longitudinal and lateral autopilot, guidance of missile and launch vehicles.

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	To Understand about basic of Guidance and control	Apply
CO2	To understand the need for automatic flight control systems	Apply
CO3	To Analysis the performance of Pitch Orientation Control system	Analysis
CO4	To understand the concept of autopilot	Apply
CO5	To understand the missile and launch vehicle guidance	Apply

Course contents:

UNIT I Introduction 4

Introduction to Guidance and control - definition, Historical background

UNIT II Augmentation Systems 7

Need for automatic flight control systems. Stability augmentation systems, control augmentation systems, Gain scheduling concepts.

UNIT III Longitudinal Autopilot 12

Displacement Autopilot-Pitch Orientation Control system, Acceleration Control System, Glide Slope Coupler and Automatic Flare Control and Flight path stabilization, Longitudinal control law design using back stepping algorithm.

UNIT IV Lateral Autopilot 10

Damping of the Dutch Roll, Methods of Obtaining Coordination, Yaw Orientation Control system turn compensation, Automatic lateral Beam Guidance. Introduction to Fly-by-wire flight control systems, Lateral control law design using back stepping algorithm.

UNIT V Missile and Launch Vehicle Guidance 12

Operating principles and design of guidance laws, homing guidance laws- short range, Medium range and BVR missiles, Launch Vehicle- Introduction, Mission requirements, Implicit guidance schemes, Explicit guidance, Q guidance schemes

Total: 45 periods

References:

1. Collinson R.P.G, 'Introduction to Avionics', Chapman and Hall, India, 1996.
2. Stevens B.L & Lewis F.L, 'Aircraft control & simulation', John Wiley Sons, New York, 1992
3. Blake Lock. J.H 'Automatic control of Aircraft and missiles ', John Wiley Sons. New York, 1990.
4. Nelson R.C 'Flight stability & Automatic Control', McGraw Hill, 1989.
5. Garnel.P. & East.D.J, 'Guided Weapon control systems', Pergamon Press, Oxford, 1977.
6. Bernad Etkin.'Dynamic of flight stability and control', John Wiley, 1972.

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

20PARE30	Avionics	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Control Engineering, Aircraft design, Air traffic control, Elements of aeronautics				

Course objectives:

The course is intended to

1. To introduce the basic of avionics and its need for civil and military aircrafts
2. To impart knowledge about the avionic architecture and various avionics data buses
3. To gain more knowledge on various avionics subsystems

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	To introduce the basic of avionics and its need for civil and military aircrafts	Apply
CO2	To impart knowledge about the avionic architecture and various avionics data buses	Apply
CO3	To study about Control and display technologies	Apply
CO4	To gaining knowledge and analysis of navigation systems	Analysis
CO5	To gain more knowledge on various avionics subsystems	Apply

Course contents:

UNIT I Introduction to Avionics 9

Need for avionics in civil and military aircraft and space systems – integrated avionics and weapon systems – typical avionics subsystems, design, technologies – Introduction to digital computer and memories.

UNIT II Digital Avionics Architecture 9

Avionics system architecture – data buses – MIL-STD-1553B – ARINC – 429, ARINC-429 – ARINC – 629.

UNIT III Flight Decks and Cockpits 9

Control and display technologies: CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil and Military Cockpits: MFDS, HUD, MFK, HOTAS.

UNIT IV Introduction to Navigation Systems 9

Radio navigation – ADF, DME, VOR, LORAN, DECCA, OMEGA, TACAN, ILS, MLS, Hyperbolic navigation systems, Ground Control Approach Systems, Dead reckoning navigation systems, Doppler navigational and inertial navigation– Inertial Navigation Systems (INS) – INS block diagram – Satellite navigation systems – Traffic Alert and Collision Avoidance System (TCAS), GPS

UNIT V Air Data Systems and Auto Pilot 9

Air data quantities – Altitude, Air speed, Vertical speed, Mach meter, Total air temperature, Mach warning, Altitude warning – Auto pilot – Basic principles, Longitudinal and lateral auto pilot

Total: 45 periods

References

1. Albert Helfrick.D., "Principles of Avionics", Avionics Communications Inc., 2004
2. Pallet E.H.J "Aircraft Instruments and Integrated Systems", Longman Scientific.2002.
3. Spitzer. C.R. "The Avionics Hand Book", CRC Press, 2000
4. Collinson.R.P G. "Introduction to Avionics". Chapman and Hall, 1996.
5. Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J., U.S.A, 1993
6. Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical" Longman Group UK Ltd., England, 1989.

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

20PARE31	Wind Tunnel Techniques	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Aerodynamics. Elements of aeronautics				

Course objectives:

The course is intended to

1. To introduce the basic of avionics and its need for civil and military aircrafts
2. To impart knowledge about the avionic architecture and various avionics data buses
3. To gain more knowledge on various avionics subsystems

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level
CO1	Learn the basic concept of Wind tunnel and its principles	Apply
CO2	Understand the various types of wind tunnels and its functions	Apply
CO3	Ability to learn testing of wind tunnel and calibration	Apply
CO4	Acquire the knowledge of measurement techniques.	Analysis
CO5	Learn the advanced types of wind tunnel.	Apply

Course contents:

UNIT I Introduction to Wind Tunnels 9

Principles of Model Testing, Wind Tunnels and its functional parts, Non dimensional numbers. Scale effect, Geometric Kinematic and Dynamic similarities.

UNIT II Types and Functions of Wind Tunnels 9

Classification and types special problems of testing in subsonic, transonic, supersonic and hypersonic speed regions Layouts

UNIT III Calibration of Wind Tunnels 9

Test section speed, Horizontal buoyancy, Flow angularities. Flow uniformity & turbulence measurements, associated instrumentation – Calibration of subsonic & supersonic tunnels.

UNIT IV Conventional measurement techniques 9

Force measurements and measuring systems. Multi component internal and external balances. Pressure measurement system - Steady and Unsteady Pressure- single and multiple measurements - Velocity measurements, Intrusive and Non-intrusive methods Particle image velocimetry.

UNIT V Advanced wind tunnel techniques 9

Intake tests store carriage and separation tests, unsteady force and pressure measurements, wind tunnel model design. Hot wire anemometer working and principle

Total: 45 periods

References

1. Rae, W.H. and Pope, A., "Low Speed Wind Tunnel Testing', Wiley India Pvt Ltd; Third edition (16 March 2010) ISBN-13: 978-8126525683
2. Lecture course on Advanced Flow diagnostic techniques 17-19 September 2008 NAL, Bangalore
3. Pope, A., and Goin, L. "High Speed Wind Tunnel Testing", Krieger Pub Co 2002.
4. NAL-UNI Lecture Series 12:" Experimental Aerodynamics", NAL SP 98 01 April 1998

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