B.TECH AERONAUTICAL ENGINEERING-2018

LIST OF ELECTIVE SUBJECTS

ELECTIVE -I						
Subject Code	Title of Subject	Ty/Lb/ETL	L	T/S.Lr	P/R	C
BAE20E01	Theory of Elasticity	Ty	3	0	0	3
BAE20E02	Aircraft General Engineering and Maintenance Practices	Ty	3	0	0	3
BAE20E03	Space Mechanics	Ty	3	0	0	3
BAE20E04	Industrial Aerodynamics	Ty	3	0	0	3
BAE20E05/ BME18E03	Turbo Machines	Ty	3	0	0	3
ELECTIVE -II						
Subject Code	Title of Subject	Ty/Lb/ETL	L	T/S.Lr	P/R	C
BAE20E06	Helicopter Theory	Ty	3	0	0	3
BAE20E07	Experimental Stress Analysis	Ty	3	0	0	3
BAE20E08	Fatigue and Fracture Mechanics	Ty	3	0	0	3
BAE20E09	UAV Systems	Ty	3	0	0	3
BAE20E10	Disaster Management	Ty	3	0	0	3
ELECTIVE -III						
Subject Code	Title of Subject	Ty/Lb/ETL	L	T/S.Lr	P/R	C
BAE20E11	Advanced Aerospace Materials	Ty	3	0	0	3
BAE20E12	Airframe Maintenance and Repair	Ty	3	0	0	3
BAE20E13	Aero Engine Maintenance and Repair	Ty	3	0	0	3
BAE20E14	Air Traffic Control and Planning	Ty	3	0	0	3
BAE20E15	Aircraft Performance	Ty	3	0	0	3
ELECTIVE -IV						
Subject Code	Title of Subject	Ty/Lb/ETL	L	T/S.Lr	P/R	C
BAE20E16	Hypersonic Aerodynamics	Ty	3	0	0	3
BAE20E17	Experimental Aerodynamics	Ty	3	0	0	3
BAE20E18	Rockets and Missiles	Ty	3	0	0	3
BAE20E19	Structural Dynamics	Ty	3	0	0	3
BAE20E20	Control Engineering	Ty	3	0	0	3

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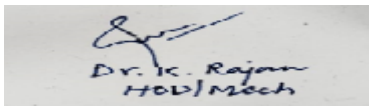
ELECTIVE- I



Subject Code: BAE20E01	Subject Name : THEORY OF ELASTICITY	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Engineering Mechanics, Strength of Materials	TY	3	0/0	0/0	3

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Practical R : Research C: Credits
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn
To apply linear elasticity in the design and analysis of structures such as beams, plates and shells

COURSE OUTCOMES (COs): The students will be able to

CO1	Understand the basic concepts in continuum mechanics of solids, including of strain, internal Force and stress (Level 2)
CO2	Apply principles of continuum mechanics to design a structure. (Level 3)
CO3	Apply hyper elasticity to determine the response of elastomer-based objects(Level 3)
CO4	Characterize materials with elastic constitutive relations. (Level 6)
CO5	Use analytical techniques to predict deformation, internal force and failure of simple solids.(Level 5)

Mapping of Course with Program Outcomes (Pos)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	2	2	1	2	1	2	2
CO2	3	3	3	2	2	2	2	1	2	1	2	2
CO3	3	3	3	2	2	2	2	1	2	1	2	2
CO4	3	3	3	2	2	2	2	1	2	1	2	2
CO5	3	3	3	2	2	2	2	1	2	1	2	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	3	2				
CO2	3	3	3	2				
CO3	3	3	3	2				
CO4	3	3	3	2				
CO5	3	3	3	2				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							

Dr. K. Rajan
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Subject Code : BAE20E01	Subject Name:THEORY OF ELASTICITY	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite : Engineering Mechanics, Strength of Materials	Ty	3	0	0	3

UNIT I BASIC EQUATIONS OF ELASTICITY **9**

Definition of Stress and Strain: Stress - Strain relationships - Equations of Equilibrium, Compatibility equations, Boundary Conditions, Saint Venant's principle - Principal Stresses, Stress Ellipsoid -Stress invariants.

UNIT II PLANE STRESS AND PLANE STRAIN PROBLEMS **9**

Airy's stress function, Bi-harmonic equations, Polynomial solutions, Simple two dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams.

UNIT III POLAR COORDINATES 9

Equations of equilibrium, Strain - displacement relations, Stress - strain relations, Airy's stress function, Axi - symmetric problems, Introduction to Dunder's table, Curved beam analysis, Lame's, Kirsch, Michell's and Boussinesque problems - Rotating discs.

UNIT IV TORSION 9

Navier's theory, St. Venant's theory, Prandtl's theory on torsion, semi- inverse method and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections. Membrane Analogy.

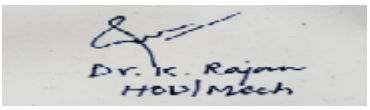
UNIT V INTRODUCTION TO THEORY OF PLATES AND SHELLS 9

Classical plate theory - Assumptions - Governing equations - Boundary conditions - Navier's method of solution for simply supported rectangular plates - Levy's method of solution for rectangular plates under different boundary conditions.

Total No. of Periods: 45

REFERENCES:

1. *Wang, C. T., "Applied Elasticity", McGraw-Hill Co., New York, 1993.*
2. *Sokolnikoff, I. S., "Mathematical Theory of Elasticity", McGraw-Hill, New York, 1978.*
3. *Volterra & J.H. Caines, "Advanced Strength of Materials", Prentice Hall, New Jersey, 1991*
4. *Barber, J. R., "Elasticity", Kluwer Academic Publishers, 2004*



Subject Code: BAE20E02	Subject Name : AIRCRAFT GENERAL ENGINEERING AND MAINTENANCE PRACTICES	Ty/Lb /ETL	L	T/ SLr	P/R	C
	Prerequisite: Elements of Aeronautical Engineering,Air carft reapair and non destructive testing lab.	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Practical R : Research C: Credits
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: To make the students learn basics of aircraft general engineering and maintenance practices.

COURSE OUTCOMES (COs) : The students will be able to

CO1	Knowledge in various ground support system for aircraft operations to carryout ground servicing of critical aircraft systems.(Level 3)
CO2	Knowledge in specifications standards of aircraft hardware systems.(Level 3)
CO3	Grasp the ground handling procedures and types of equipments with special maintenance.(Level 1)
CO4	Ability to do shop safety, Environment cleanliness in an aircraft materials shop.(Level 2)
CO5	Understand the FAA airworthiness regulations and the checklist involved in each inspection of aircraft.(Level 2)

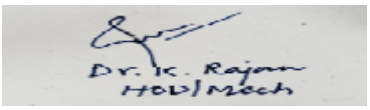
Mapping of Course with Program Outcomes (Pos)

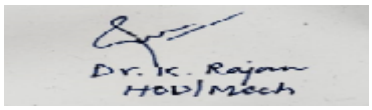
Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3		3		3					3
CO2	3	3	3		3			3				3
CO3	3	3			3	3			3			3
CO4	3	3			3		3				3	3
CO5	3	3			3							3

Cos / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**				
CO1	3	2	2	1				
CO2	3	2	2	1				
CO3	3	2	2	1				
CO4	3	2	2					
CO5	3	2	2	1				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			

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Subject Code : BAE20E02	Subject Name:AIRCRAFT GENERAL ENGINEERING AND MAINTENANCE PRACTICES	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: -- Elements of Aeronautical Engineering,Air carft reapair and non destructive testing lab.	Ty	3	0/0	0/0	3

UNIT IAIRCRAFT GROUND HANDLING AND SUPPORT EQUIPMENT **10**

Mooring, jacking, leveling and towing operations - Preparation - Equipment - precautions - Engine starting procedures - Piston engine, turboprops and turbojets - Engine fire extinguishing - Ground power unit.

UNIT IIGROUND SERVICING OF VARIOUS SUB SYSTEMS **8**

Air conditioning and pressurization - Oxygen and oil systems - Ground units and their maintenance.

UNIT IIIMAINTENANCE OF SAFETY **5**

Shop safety - Environmental cleanliness - Precautions

UNIT IV INSPECTION **10**

Process - Purpose - Types - Inspection intervals - Techniques - Checklist - Special inspection -Publications, bulletins, various manuals - FAR Air worthiness directives - Type certificate Data sheets-ATA Specifications

UNITVAIRCRAFT HARDWARE, MATERIALS, SYSTEM PROCESSES **12**

Hand tools - Precision instruments - Special tools and equipments in an airplane maintenance shopIdentification terminology - Specification and correct use of various aircraft hardware (i.e. nuts, bolts, rivets, screws etc) - American and British systems of specifications - Threads, gears, bearings, etc -Drills, tapes and reamers - Identification of all types of fluid line fittings. Materials, metallic and non-metallic Plumbing connectors - Cables - Swaging procedures, tests, Advantages of swaging over splicing.

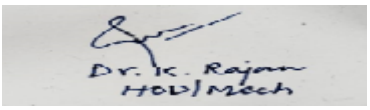
Total No. of Periods: 45

TEXT BOOK

1. Kroes Watkins Delp, "Aircraft Maintenance and Repair", McGraw Hill, New York, 1993

REFERENCES

1. *A&P Mechanics, "Aircraft Hand Book", F A A Himalayan Book House, New Delhi, 1996*
2. *A&P Mechanics," General Hand Book", F A A Himalayan Bok House, New Delhi, 1996*



Subject Code: BAE20E03	Subject Name: SPACE MECHANICS	Ty/Lb /ETL	L	T/ SLr	P/R	C
	Prerequisite: Engineering Physics, Engineering Mechanics, Strength of Materials, Propulsion-I	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Practical R : Research C: Credits
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will acquire
The knowledge towards the space mission

COURSE OUTCOMES (COs): The students will be able to

CO1	Understand the concepts of solar system (Level 2)
CO2	Describe the motions of N-body problem and the concepts of orbital mechanics. (Level 3)
CO3	Application of various satellite perturbation methods. (Level 4)
CO4	Develop the dynamic model in motion of orbiting bodies.(Level 6)
CO5	Design the various types of interplanetary trajectories. (Level 5)

Mapping of Course with Program Outcomes (Pos)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	2	2	1	2	2	2	2
CO2	3	3	3	2	2	2	2	1	2	2	2	2
CO3	3	3	3	2	2	2	2	1	2	2	2	2
CO4	3	3	3	2	2	2	2	1	2	2	2	2
CO5	3	3	3	2	2	2	2	1	2	2	2	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	3	2				
CO2	3	3	3	2				
CO3	3	3	3	2				
CO4	3	3	3	2				
CO5	3	3	3	2				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
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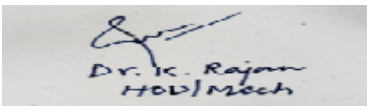


Subject Code: BAE20E03	Subject Name: SPACE MECHANICS	Ty/Lb /ETL	L	T/ SLr	P/R	C
	Prerequisite: Engineering Physics, Engineering Mechanics, Strength of Materials, Propulsion-I	Ty	3	0/0	0/0	3

UNIT I SPACE ENVIRONMENT **8**

Peculiarities of space environment and its description- effect of space environment on materials of spacecraft structure and astronauts- manned space missions - effect on satellite life time

UNIT II BASIC CONCEPTS AND THE GENERAL N-BODY PROBLEM **10**

The solar system - reference frames and coordinate systems - terminology related to the celestial sphere and its associated concepts - Kepler's laws of planetary motion and proof of the laws -Newton's universal law of gravitation - the many body problem - Lagrange-Jacobi identity - the circular restricted three body problem - libration points - the general N-body problem - two body problem - relations between position and time.

UNIT III SATELLITE INJECTION AND SATELLITE PERTURBATIONS **10**

General aspects of satellite injection - satellite orbit transfer - various cases - orbit deviations due to injection errors - special and general perturbations - Cowell's method and Encke's method - method of variations of orbital elements - general perturbations approach.

UNIT IV INTERPLANETARY TRAJECTORIES **8**

Two-dimensional interplanetary trajectories - fast interplanetary trajectories - three dimensional interplanetary trajectories - launch of interplanetary spacecraft - trajectory estimation about the target planet - concept of sphere of influence - Lambert's theorem

UNITV BALLISTIC MISSILE TRAJECTORIES **9**

Introduction to ballistic missile trajectories - boost phase - the ballistic phase - trajectory geometry -optimal flights - time of flight - re-entry phase - the position of impact point - influence coefficients.

Total No. of Periods: 45

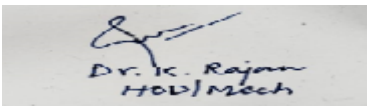
TEXT BOOKS:

1. Cornelisse, J.W., "Rocket Propulsion and Space Dynamics", J.W. Freeman & Co.,Ltd, London, 1982

2. Parker, E.R., "Materials for Missiles and Spacecraft", McGraw Hill Book Co. Inc., 1982.

REFERENCES:

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edition, 1993.



Subject Code: BAE20E04	Subject Name : INDUSTRIAL AERODYNAMICS	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Aerdynamics I &II	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Practical R : Research C: Credits
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

- **OBJECTIVES:** To familiarize the learner with non-aeronautical uses of aerodynamics such as road vehicle, building aerodynamics and problems of flow induced vibrations.

COURSE OUTCOMES (COs) : The students will be able to

CO1	Use of aerodynamics for non-aerodynamics such as vehicle, building. (Level 3)
CO2	Identify the atmospheric boundary layer and applications of wind energy collectors. (level 3)
CO3	Solve the problems and able to analyse vibrations during flow (Level 5)
CO4	Analyze the aerodynamics of road vehicles, building and problems of flow induced vibrations. (Level 4)
CO5	Analyze the model measurements, Lift and drag measurements though various techniques and testing of different models. (Level 4)

Mapping of Course with Program Outcomes (Pos)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2										3	
CO2	3	2									2	
CO3			3									
CO4	2	3	3								2	
CO5	3											

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3		2					
CO2								
CO3			3					
CO4	2		2					
CO5	2							

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							

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Subject Code: BAE20E04	Subject Name : INDUSTRIAL AERODYNAMICS	Ty/Lb/ETL	L	T/SLr	P/R	C
	Prerequisite: Aerdynamics I &II	Ty	3	0/0	0/0	3

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 IVBUILDING 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.

UNITV FLOW INDUCED VIBRATIONS **9**

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

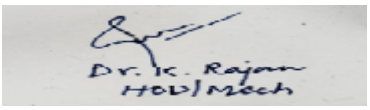
Total No. of Periods: 45

TEXT BOOKS:

1. M.Sovran (Ed), "Aerodynamics and drag mechanisms of bluff bodies and Road vehicles", Plenum press, New York, 1978.
2. Sachs. P., "Winds forces in Engineering", Pergamon Press, 1978.

REFERENCES:

1. *Blevins. R.D., "Flow Induced Vibrations", Van Nostrand, 1990.*
2. *Calvent. N.G., "Wind Power Principles", Charles Griffin & Co., London, 1979.*



Subject Code : BAE 20E05/ BME18E03	Subject Name : TURBO MACHINES	Ty/Lb/ETL	L	T/ SLr	P/R	C
	Prerequisite: GDJP, Fluid Mechanics, Thermal Engineering	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Practical R : Research C: Credits
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE: The course aims at giving an overview of different types of turbo machinery used for energy transformation, such as pumps, fans, compressors, as well as hydraulic, steam and gas-turbines.

COURSE OUTCOMES (COs) : The Student will be able to

CO1	Understand the concepts of turbo machines and its applications. (Level 2)
CO2	Analyze the performance of turbo machines using first law of thermodynamics. (Level 4)
CO3	Solve the turbo machines problems using velocity triangle concepts. (Level 3)
CO4	Understand the working principles of centrifugal and axial flow compressors and analyse its performance. (Level 2)
CO5	Calculate stage losses, stage efficiency and pressure ratio in axial flow compressor. (Level 3)
CO6	Evaluate the performance characteristics of axial and radial flow turbines. (Level 4)

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	-	1	1	1	1	1	-	1
CO2	3	3	2	1	-	1	1	1	1	2	-	1
CO3	3	3	3	1	-	1	1	1	1	2	-	1
CO4	3	3	2	-	-	1	1	1	1	1	-	1
CO5	3	3	2	1	-	1	1	1	1	2	-	1
CO6	3	3	2	1	-	2	1	2	1	2	-	1

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1
CO2	3	2	2	1
CO3	3	2	2	1
CO4	3	2	2	1
CO5	3	2	2	1
CO6	3	2	2	1

3/2/1 indicates Strength of Correlation: 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					✓							

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Subject Code : BAE 20E05/ BME18E03	Subject Name : TURBO MACHINES	Ty/Lb/ETL	L	T/SLr	P/R	C
	Prerequisite: GDJP, Fluid Mechanics, Thermal Engineering	Ty	3	0/0	0/0	3

UNIT- 1 INTRODUCTION **9**

Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification, Application of first and second laws of thermodynamics to turbo machines.

UNIT- 2 ENERGY EXCHANGE INTURBOMACHINES **9**

Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor.

UNIT- 3 CENTRIFUGALCOMPRESSORS **9**

Construction details, types, impeller flow losses, slip factor, diffuser analysis losses and performance curves.

UNIT- 4 AXIAL AND RADIALFLOW COMPRESSORS **9**

Axial and radial flow compressors and pumps– general analysis, Effect of blade discharge angle on performance, Theoretical head – capacity relationship.

UNIT- 5 AXIAL AND RADIALFLOW TURBINES **9**

Velocity diagrams, losses and coefficients, blade design principles, testing and performance characteristics.

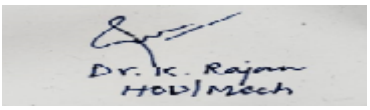
Total No.of Periods 45

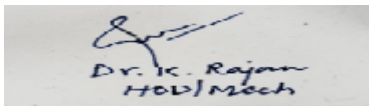
TEXT BOOKS:

1. Gas Turbine, V.Ganesan, Tata McGraw Hill Co. Ltd., 3rd edition,2010
2. Turbines, Compressors & Fans, S. M. Yahya, Tata McGraw HillCo. Ltd., 2nd edition,2002

REFERENCE BOOKS:

1. D. G. Shepherd, "Principals of Turbo machines" , the Macmillan Company(1964).
2. S. L.Dixon, "Fluid Mechanics & Thermodynamics of Turbo machines", Elsevier(2005).
3. B.K.Venkanna, "Turbomachine", PHI, New Delhi 2009.
4. M. S. Govindgouda and A. M.Nagaraj, "A Text Book of Turbomachines", , M. M. Publications, 4Th Ed,2008.
5. V. Kadambi and Manohar Prasad, "An Introduction to Energy Conversion, Volume III, Turbo machinery", New Age International Publishers, reprint2008.

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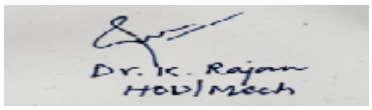
ELECTIVE- II



Subject Code : BAE 20E06	Subject Name : HELICOPTER THEORY	Ty/Lb/ ETL	L	T/S Lr	P/R	C
	Prerequisite : Elements of Aeronautical Engineering	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
Ty/Lb/ETL : Theory / Lab / Embedded Theory and Lab

OBJECTIVES :

- To make the student familiarize with the principles involved in helicopters and to study the performance and stability aspects of Helicopter under different operating conditions. .

COURSE OUTCOMES (Cos)

Students completing the course were able to

CO1	To perform the Aerodynamics calculation of Rotor blade (Level 4)
CO2	Analyze and control Rotor vibration(Level 4)
CO3	Understand stability and control characteristics of Helicopter (Level 4)
CO4	Expose to the power plants and flight performance (Level 3)
CO5	Demonstrate the Stress analysis of the blade (Level 4)

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	3		2	2		2
CO2	3	3	3	3	3	2	3		2	2		2
CO3	3	3	3	3	3	2	3		2	2		2
CO4	3	3	3	3	3	2	2		2	2		2
CO5	3	3	3	3	3	2	2		2	2		2
Cos / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**								
CO1	3	3	3									
CO2	3	3	3	2								
CO3	3	3	3	2								
CO4	3	3	3									
CO5	3	2	3									

H/M/L indicates strength of correlation H – High, M – Medium, L – Low

Category	Basic Sciences	Engg Sciences	Humanities & Social Sciences	Program core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skills	Soft Skills
					√				

Dr. K. Rajan
HOD/Mech

Subject Code : BAE 20E06	Subject Name : HELICOPTER THEORY	Ty/Lb/ETL	L	T/SLr	P/R	C
	Prerequisite : Elements of Aeronautical Engineering	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION **9**

Helicopter as an aircraft, Basic features, Layout, Generation of lift, Main rotor, Gearbox, tail rotor, power plant, considerations on blade, flapping and feathering, Rotor controls and various types of rotor, Blade loading, Effect of solidity, profile drag, compressibility etc., Blade area required, number of Blades, Blade form, Power losses, Rotor efficiency.

UNIT II AERODYNAMICS OF ROTOR BLADE **9**

Aerofoil characteristics in forward flight, Hovering and Vortex ring state, Blade stall, maximum lift of the helicopter calculation of Induced Power, High speed limitations; parasite drag, power loading, ground effect.

UNIT III POWER PLANTS AND FLIGHT PERFORMANCE **9**

Piston engines, Gas turbines, Ramjet principle, Comparative performance, Horsepower required, Range and Endurance, Rate of Climb, Best Climbing speed, Ceiling in vertical climb, Autorotation.

UNIT IV STABILITY AND CONTROL **9**

Physical description of effects of disturbances, Stick fixed Longitudinal and lateral dynamic stability, lateral stability characteristics, control response. Differences between stability and control of airplane and helicopter.

UNITV ROTOR VIBRATIONS **9**

Dynamic model of the rotor, Motion of the rigid blades, flapping motion, lagging motion, feathering motion, Properties of vibrating system, phenomenon of vibration, fuselage response, vibration absorbers, Measurement of vibration in flight. Rotor Blade Design: General considerations, Airfoil selection, Blade construction, Materials, Factors affecting weight and cost, Design conditions, Stress analysis.

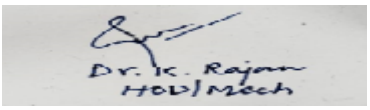
Total No. of Periods: 45

TEXT BOOKS:

1. John Fay, "The Helicopter and How It Flies", Himalayan Books 1995
2. Lalit Gupta, "Helicopter Engineering", Himalayan Books New Delhi 1996

REFERENCES:

1. *Joseph Schafer, "Basic Helicopter Maintenance", Jeppesen 1980*
2. *R WProuty, "Helicopter Aerodynamics*"



Dr. M.G.R.
EDUCATIONAL AND RESEARCH INSTITUTE
(Deemed to be University)
University with Graded Autonomy Status
Periyar E.V.R. Salai, Maduravoyal, Chennai – 95

Subject Code: BAE 20E07	Subject Name : EXPERIMENTAL STRESS ANALYSIS	Ty/Lb/ETL	L	T/SLr	P/R	C
	Prerequisite: Engineering Mechanics,Strength of Materials.	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Practical R : Research C: Credits
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn
The Various Experimental techniques involved for measuring displacement, stresses and strain in structural components and also NDT techniques.

COURSE OUTCOMES (COs) : The students will be able to

CO1	Analyze the performance of measuring instrumentation(Level 4)
CO2	Impart knowledge on different methods of strain measurement (Level 2)
CO3	Design different strain gauge circuits (Level 4)
CO4	Use photoelasticity for stress analysis (Level 3)
CO5	Expose to the different types of Non Destructive Testing methods(Level 3)

Mapping of Course with Program Outcomes (Pos)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		2	2	2			2	2		2
CO2	3	2			2	2			2	2		2
CO3	3	3	3	3	2	2			2	2		2
CO4	3	3	3	3	3	2			2	2		2
CO5	3	3		2	3	2				2		2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3		2	2				
CO2	3		3	3				
CO3	3	3	3	3				
CO4	3		3	3				
CO5	3		3	3				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							

Dr. K. Rajan
HOD/Mech

Subject Code: BAE 20E07	Subject Name : EXPERIMENTAL STRESS ANALYSIS	Ty/Lb/ETL	L	T/ SLr	P/R	C
	Prerequisite: Engineering Mechanics,Strength of Materials.	Ty	3	0/0	0/0	3

UNIT I BASICS OF MECHANICAL MEASUREMENTS **9**

Basic Characteristics and Requirements of a Measuring System – Principles ofMeasurements– Precision, Accuracy, Sensitivity and Range of Measurements – Sources of Error – Statistical Analysis of Experimental Data – Contact Type Mechanical Extensometers – Advantages and Disadvantages – Examples of Non -Contact Measurement Techniques

UNIT II ELECTRICAL-RESISTANCE STRAIN GAUGES **9**

Strain Sensitivity in Metallic Alloys – Gage Construction – Gage Sensitivities and Gage FactorCorrections for Transverse Strain Effects – Performance Characteristics of Foil StrainGagesMaterials Used for Strain Gauges – Environmental Effects – The Three-Element Rectangular Rosette for Strain Measurement – Other Types of Strain Gages – Semiconductor StrainGagesGrid & Brittle Coating Methods of StrainAnalysis

UNIT III STRAIN-GAUGE CIRCUITS & INSTRUMENTATION **9**

The Potentiometer Circuit and Its Application to Strain Measurement – Variations From Basic Circuit –Circuit Output – The Wheatstone Bridge Circuit – Current and Constant Voltage Circuits – Analog to Digital conversion – Calibrating Strain-Gage Circuits – Effects of Lead Wires and Switches – Electrical Noise -– Strain Measurement in Bars, Beams and Shafts – Circuit Sensitivity & Circuit Efficiency.

UNIT IV PHOTOELASTIC METHODS OF STRESS ANALYSIS **9**

Introduction to Photoelastic Methods – Stress-Optic Law – Effects of a Stressed Model in a Plane Polariscope – Effects of a Stressed Model in a Circular Polariscope - Tardy Compensation - Two-Dimensional Photoelastic Stress Analysis – Fringe Multiplication and Fringe Sharpening - Materials for Two-Dimensional Photoelasticity - Properties and Calibration of Commonly Employed Photoelastic Materials – Introduction to Three-Dimensional Photoelasticity.

UNIT V NON-DESTRUCTIVE TESTING **9**

DifferenttypesofNDTTechniques-AcousticEmissionTechnique–Ultrasonics–Pulse-Echo– Through Transmission – Eddy Current Testing – Magnetic Particle Inspection – X-Ray Radiography – Challenges in Non-Destructive Evaluation – Non-Destructive Evaluationin
Composites – Image Processing Basics.

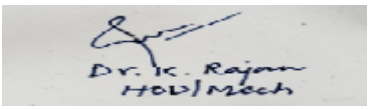
Total No. of Periods: 45

TEXT BOOKS:

1. Dally, J.W., and Riley, W.F., Experimental Stress Analysis, McGraw Hill Inc., New York 1998.
2. Sadhu Singh, Experimental Stress Analysis, Khanna Publishers, New Delhi,2009.
3. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K.,
4. Experimental Stress Analysis, Tata McGraw Hill, NewDelhi,1984.

REFERENCES:

1. Albert1. Kobayashi,'HandbookonExperimentalMechanics,PrenticeHall Publishers,2008.
2. Durelli, A.J.Applied Stress Analysis, Prentice Hall of India Pvt Ltd., New Delhi,1970.
Hetenyi, M., Hand book of Experimental Stress Analysis, John Wiley and Sons Inc., New York,1972.
3.JamesF.DoyleandJamesW.Phillips,'ManualonExperimentalStressAnalysis',5th Edition,1989.
Ramesh, K., Digital Photoelasticity, Springer, New York,2000.



Subject Code: BAE20E08	Subject Name: FATIGUE AND FRACTURE MECHANICS	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Engineering Mechanics, Strength of Materials& Flight Mechanics.	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Practical R : Research C: Credits
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- To analyse the fracture mechanism under various conditions.

COURSE OUTCOMES (COs) : The students will be able to

CO1	Identify and describe the basic fracture and fatigue mechanisms(Level 2)
CO2	Understand crack resistance and energy release rate for crack criticality.(Level 3)
CO3	Application of Linear Elastic Fracture Mechanics on brittle materials.(Level 4)
CO4	Correctly identify the cause of failure of a material based on fracture surface observations. (Level 6)
CO5	Understanding of experimental techniques to determine the critical values of parameters at crack tip(Level 5)

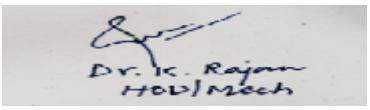
Mapping of Course with Program Outcomes (Pos)

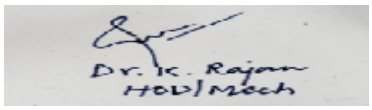
Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	2	2	1	2	1	2	2
CO2	3	3	3	2	2	2	2	1	2	1	2	2
CO3	3	3	3	2	2	2	2	1	2	1	2	2
CO4	3	3	3	2	2	2	2	1	2	1	2	2
CO5	3	3	3	2	2	2	2	1	2	1	2	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	3	2				
CO2	3	3	3	2				
CO3	3	3	3	2				
CO4	3	3	3	2				
CO5	3	3	3	2				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			




Dr. K. Rajan
HOD/Mech

Subject Code: BAE20E08	Subject Name: FATIGUE AND FRACTURE MECHANICS	Ty/Lb/ETL	L	T/ SLr	P/R	C
	Prerequisite: Engineering Mechanics,Strength of Materials& Flight Mechanics.	Ty	3	0/0	0/0	3

UNIT I FATIGUE OF STRUCTURES **7**

S.N. curves - Endurance limits - Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams - Notches and stress concentrations - Neuber's stress concentration factors - Plastic stress concentration factors - Notched S.N. curves - Fatigue of composite materials.

UNIT II STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR **10**

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 IIIPHYSICAL ASPECTS OF FATIGUE **10**

Phase in fatigue life - Crack initiation - Crack growth -surfaces.Final Fracture - Dislocations - fatigue fracture

UNIT IV FRACTURE MECHANICS **10**

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.

UNITV FATIGUE DESIGN AND TESTING **8**

Safe life and Fail-safe design philosophies - Importance of Fracture Mechanics in aerospace structures - Application to composite materials and structures

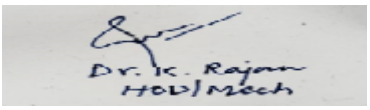
Total No. of Periods: 45

TEXT BOOKS:

1. Prasanth Kumar, "Elements of fracture mechanics", Wheeter publication, 1999.
2. Barrois W, Ripely, E.L., "Fatigue of aircraft structure," Pergamon press. Oxford, 1983.

REFERENCES:

1. Sih C.G., "Mechanics of fracture." Vol - I, Sijthoff and w Noordhoff International Publishing Co., Netherlands, 1989.
2. Knott, J.F., "Fundamentals of Fracture Mechanics," - Buterworth & Co., Ltd., London, 1983.
3. Kare Hellan .'Introduction to Fracture Mechanics', McGraw Hill, Singapore, 1985



Subject Code : BAE 20E09	Subject Name : UAV SYSTEMS	Ty/Lb /ETL	L	T/SLr	P/R	C
	Prerequisite : Elements of Aernautical Engineering	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
TY/LB/ETL: Theory / Lab / Embedded Theory and Lab

OBJECTIVES :

- To make the students to understand the basic concepts of UAV systems design

COURSE OUTCOMES (Cos)

Students completing the course were able to

CO1	Outline the fundamentals of UAV(2)
CO2	Illustrate the designs of UAV systems(4)
CO3	Understand the principles and applications of Avionics hardware (3)
CO4	Estimate the payloads and operation range of UAV.(4)
CO5	Test the UAV and develop ground control software (4)

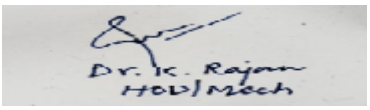
Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											2
CO2	3	3	3	3	3	3	3	2	2	3	2	2
CO3	3	3	3		3		2		2	2		2
CO4	3	3	3	3	3	2	2		2	2	2	2
CO5	3	3	3	3	3		3	2	2	2	2	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3			
CO2	3	3	2	
CO3	3	3		3
CO4	3	3	3	
CO5	3			3

H/M/L indicates strength of correlation H – High, M – Medium, L – Low

Category	Basic Sciences	Engg Sciences	Humanities & Social Sciences	Program core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skills	Soft Skills
					√				



Subject Code : BAE 20E09	Subject Name : UAV SYSTEMS	Ty/Lb/ETL	L	T/SLr	P/R	C
	Prerequisite : Elements of Aernautical Engineering	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION TO UAV **9**

History of UAV -classification - Introduction to Unmanned Aircraft Systems-models and prototypes -System Composition-applications

UNIT II THE DESIGN OF UAV SYSTEMS **9**

Introduction to Design and Selection of the System- Aerodynamics and Airframe Configurations-Characteristics of Aircraft Types- Design Standards and Regulatory Aspects-UK,USA and Europe-Design for Stealth-control surfaces-specifications.

UNIT III AVIONICS HARDWARE **9**

Autopilot - AGL-pressure sensors-servos-accelerometer -gyros-actuators- power supply-processor, integration, installation, configuration, and testing

UNIT IV COMMUNICATION PAYLOADS AND CONTROLS **9**

Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequency range -modems-memory system-simulation-ground test-analysis-trouble shooting

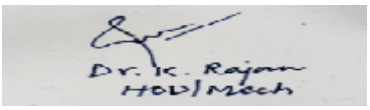
UNIT V THE DEVELOPMENT OF UAV SYSTEMS **9**

Waypoints navigation-ground control software- System Ground Testing- System In-flight Testing-Future Prospects and Challenges-Case Studies - Mini and Micro UAVs.

Total No. of Periods: 45

REFERENCES:

1. *Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010.*
2. *Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.*
3. *Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007*
4. *Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 1998*
5. *Dr. Armand J. Chaput, "Design of Unmanned Air Vehicle Systems", Lockheed Martin Aeronautics Company, 2001*



Subject Code:	Subject Name : DISASTER MANAGEMENT	Ty/Lb/ ETL	L	T/ SLr	P/R	C
BAE20E10	**Prerequisite:** NIL	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Practical : Research C: Credits
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES:

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction.

.

COURSE OUTCOMES (COs) : The students will be able to

CO1	Understanding various types of disasters, their causes and impacts. (Level 2)
CO2	Apply the various disaster risk reduction approaches (Level 3)
CO3	Analyze the relationship between disaster and development (Level 4)
CO4	Application of technologies in disaster relief(Level 3)
CO5	Conduct of case studies on various disasters like earth quake, drought, flooding etc(Level 5)

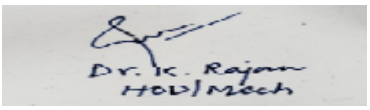
Mapping of Course with Program Outcomes (Pos)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	3	3	1	2	1	2	2
CO2	3	3	3	3	2	3	3	1	2	2	2	2
CO3	3	2	3	2	2	3	3	2	2	2	2	2
CO4	3	3	3	3	3	3	1	1	2	2	2	2
CO5	3	3	3	3	3	2	2	1	2	2	2	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	2	2	2	3				
CO2	2	2	2	3				
CO3	2	2	2	3				
CO4	2	2	2	3				
CO5	2	2	2	3				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							



Subject Code: BAE20E10	Subject Name : DISASTER MANAGEMENT	Ty/Lb/ETL	L	T/SLr	P/R	C
	Prerequisite: NIL	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION TO DISASTERS **9**

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks - Disasters: Types of disasters -Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

UNIT II APPROACHES TO DISASTER RISK REDUCTION (DRR) **9**

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processess and Framework at State and Central Level- State Disaster Management Authority(SDMA) - Early Warning System - Advisories from Appropriate Agencies.

UNIT III INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT **9**

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT IV DISASTER RISK MANAGEMENTS INDIA **9**

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation - Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster - Disaster Damage Assessment.

UNIT V DISASTER MANAGEMENT:APPLICATIONS AND CASE STUDIES AND FIELDWORKS **9**

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

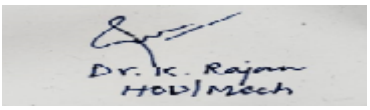
Total No. of Periods: 45

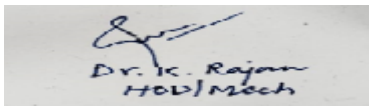
TEXTBOOK:

1. Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
2. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361]
3. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011
4. Kapur Anu Vulnerable India: A Geographical Study of Disasters, MAS and Sage Publishers, New Delhi, 2010.

REFERENCES

1. *Govt, of India: Disaster Management Act, Government of India, New Delhi, 2005*
2. *Government of India, National Disaster Management Policy,2009*




Dr. K. Rajan
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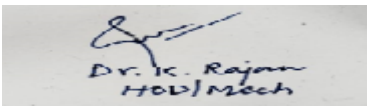
ELECTIVE- III



Subject Code: BAE 20E11	Subject Name : ADVANCED AEROSPACE MATERIALS	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Material science , Aircraft Materials and Processes	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Practical R : Research C: Credits
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

- On the mechanical behavior and characterization of various materials, that are used for aircraft applications.

COURSE OUTCOMES (COs) : The students will be

CO1	Understanding the properties and mechanical behavior of conventional and high performance alloys, used for Aircraft applications (Level 2)
CO2	Applying and relating, the high temperature materials for critical applications in an aircraft (Lever 3)
CO3	Evaluating and Characterization of material structure using different techniques (Level 5)
CO4	Analyzing the scope of smart materials for Aerospace application (Level 4)
CO5	Differentiating and analyzing the different materials with respect to their Characterization, behavior and performances. (Level 5)

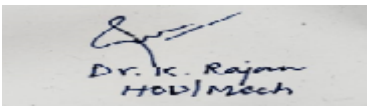
Mapping of Course with Program Outcomes (Pos)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	1	2	2	1	2	2	2	2
CO2	3	2	2	2	2	2	2	1	2	2	2	2
CO3	3	2	3	2	3	2	2	1	2	2	2	2
CO4	3	2	3	3	2	3	3	1	2	2	2	2
CO5	3	3	3	3	2	2	2	1	2	2	2	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	2	3	2				
CO2	3	3	3	2				
CO3	3	3	3	2				
CO4	3	3	3	2				
CO5	3	3	3	2				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							



Subject Code: BAE 20E11	Subject Name : ADVANCED AEROSPACE MATERIALS	Ty/Lb/ ETL	L	T/ SL r	P/R	C
	Prerequisite: Material science , Aircraft Materials and Processes	Ty	3	0/0	0/0	3

UNIT I MECHANICAL BEHAVIOUR **9**

Properties of Conventional Aircraft Materials – Linear and Non-Linear Behaviour – Yielding, Strain Hardening and Fracture – Design for Strength – General Requirements of Materials for Aerospace Applications – Principles of Stressed Skin Construction – Effect of Manufacturing Procedures on Material Behaviour – Micro-structural Influence of Mechanical Behaviour

UNIT II HIGH PERFORMANCE ALLOYS **9**

High Performance Alloys For Aerospace Application – Aluminium, Magnesium, and Titanium alloys – Comparison of Properties – Steel Quality & Effect of Carbon Content – Effect of Alloying & Heat Treatments – Properties of Advanced Alloys used in Aircraft – Effect of Corrosion on Mechanical properties – Stress Corrosion Cracking – Corrosion Resistance Materials – Heat Resistance Alloys – Effect of Alloying Elements & Ideal Percentage Composition

UNIT III HIGH TEMPERATURE MATERIALS **9**

Carbon/Carbon composites – Properties & Advantages – Fabrication Processes – Metal Matrix Composites – Mechanical Properties – Mechanical and Thermal Properties of Materials at Elevated Temperatures – Super Alloys – Ceramic Material Systems and Their Properties – Fabrication of Ceramic Composites – Cermet Tools – Application of These Materials in The Thermal Protection Systems of Aerospace Vehicles – Application of High Temperature Materials in an Aircraft.

UNIT IV CHARACTERIZATION OF MATERIAL STRUCTURE **9**

X- Ray Diffraction And Their Applications – Absorption of X-rays and filters - X-ray – Diffraction Directions - Working Principles of Transmission Electron Microscopes – Image Formation – Resolving Power – Magnification & Depth of Focus – Advanced Chemical and Thermal analysis – Basic Principles & Practice – Augur Spectroscopy – Differential Thermal Analysis.

UNIT V SMART MATERIALS FOR AEROSPACE APPLICATION **9**

Fundamentals of Piezoelectricity – Soft and Hard Piezoelectric Ceramics – Basic Piezoceramic Characteristics – Shape Memory Alloys - Fundamentals of Shape Memory Alloy (SMA) Behavior – Phase Transformation – Lattice Structure and DeformationMechanism – Origin of the One-Way Shape Memory Effect – Stress Induced Martensite and Pseudoelasticity – Two-Way Shape Memory Effect.

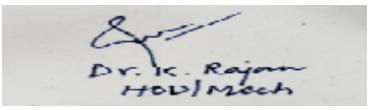
Total No. of Periods: 45

TEXT BOOKS:

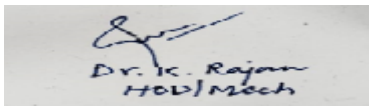
1. Adrian Mouritz,'AIAA Education Series – Introduction to Aerospace Materials,2012.
2. Titterton.G., Aircraft Materials and Processes, V Edition, Pitman Publishing Co., 1995.

REFERENCES:

1.J.W. Martin, Engineering Materials, Their properties and Applications, Wykedham Publications (London) Ltd.,1987.
2.N.Prasad, Eswara,R. J. H Wanhill, Aerospace Materials and Material Technologies – Indian Institute of Metals Series,2017.
3.V. Raghavan. Materials Science and Engineering, Prentice Hall of India, New Delhi, 5th edition,2004.
4.Sam Zhang, 'Aerospace Materials Handbook (Advances in Materials Science and Engineering) 1st



Edition,2016.
5.L.H. Van Vlack, Elements of Materials Science and Engineering Prentice Hall; publishers, 6th edition, 1989



Subject Code:	Subject Name :	Ty/Lb/ETL	L	T/ SLr	P/R	C
BAE 20E12	AIRFRAME MAINTENANCE AND REPAIR					
	Prerequisite: Strength of Materials; Aircraft Structures	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Practical R : Research C: Credits
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: To make the students to understand the Airframe components and the tools used to maintain the components. Defect investigation, methods to carry out investigation and the detailed maintenance and practice procedures

COURSE OUTCOMES (COs): The students will be able to

CO1	Understand the Airframe components and the tools used to maintain the components (Level 2)
CO2	Apply the knowledge of plastics and composites in aircraft maintenance. (Level 4)
CO3	Carry out aircraft jacking, assembly and rigging in maintenance(Level 4)
CO4	Apply hydraulic and pneumatic system during trouble shooting and maintenance practice. (Level 5)
CO5	Apply the safety practices in aircraft management.(Level 6)

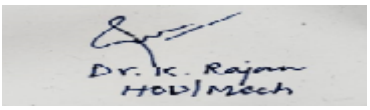
Mapping of Course with Program Outcomes (Pos)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	3	3	3	2	2
CO2	3	3	3	3	3	2	2	3	3	3	2	2
CO3	3	3	3	3	3	2	2	3	3	3	2	2
CO4	3	3	3	3	3	2	2	3	3	3	2	2
CO5	3	3	3	3	3	2	2	3	3	3	2	2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	3	3				
CO2	3	3	3	3				
CO3	3	3	3	3				
CO4	3	3	3	3				
CO5	3	3	3	3				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							



Subject Code: BAE 20E12	Subject Name : AIRFRAME MAINTENANCE AND REPAIR	Ty/Lb/ETL	L	T/SLr	P/R	C
	Prerequisite: Strength of Materials; Aircraft Structures	Ty	3	0/0	0/0	3

UNIT I MAINTENANCE OF AIRCRAFT STRUCTURAL COMPONENTS 9

Equipments used in welding shop and their maintenance - Ensuring quality welds - Welding jigs and fixtures - Soldering and brazing - laser welding.

Sheet metal repair and maintenance: Selection of materials; Repair schemes; Fabrication of replacement patches; Tools - power/hand; Repair techniques; Peening - Close tolerance fasteners; Sealing compounds; forming/shaping; Calculation of weight of completed repair; Effect of weight -change on surrounding structure. Sheet metal inspection - N.D.T. Testing. Riveted repair design -Damage investigation - Reverse engineering.

UNIT II PLASTICS AND COMPOSITES IN AIRCRAFT 9

Review of types of plastics used in airplanes - Maintenance and repair of plastic components - Repair of cracks, holes etc., various repairs schemes - Scopes.

Cleaning of fibre reinforced plastic (FRP) materials prior to repair; Break test - Repair Schemes; FRP/honeycomb sandwich materials; laminated FRP structural members and skin panels; Tools/equipment; Vacuum-bag process. Special precautions - Autoclaves

UNIT III AIRCRAFT JACKING, ASSEMBLY AND RIGGING 9

Airplane jacking and weighing and C.G. Location. Balancing of control surfaces- Inspection maintenance. Helicopter flight controls. Tracking and balancing of main rotor.

UNIT IV REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM 12

Trouble shooting and maintenance practices - Service and inspection - Inspection and maintenance of landing gear systems. - Inspection and maintenance of air-conditioning and pressurization system, water and waste system. Installation and maintenance of Instruments - handling - Testing -Inspection. Inspection and maintenance of auxiliary systems - Rain removal system - Position and warning system - Auxiliary Power Units (APUs).

UNITV SAFETY PRACTICES 6

Hazardous materials storage and handling, Aircraft furnishing practices - Equipments. Trouble shooting. Theory and practices.

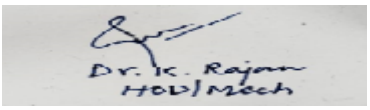
Total No. of Periods: 45

TEXT BOOKS:

1. Kroes, Watkins, Delp, "Aircraft Maintenance and Repair", McGraw Hill, New York, 1992.

REFERENCES:

1. *Larry Reithmeir, "Aircraft Repair Manual", Palamar Books, Marquette, 1992.*
2. *Brimm D.J. Bogges H.E., "Aircraft Maintenance", Pitman Publishing corp., New York, 1940.*
3. *Delp. Bent and Mckinely "Aircraft Maintenance Repair", McGraw Hill, New York, 1987.*



Subject Code: BAE20E13	Subject Name : AERO ENGINE MAINTENANCE AND REPAIR	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Aircraft Systems,Aero Engine and Airframe laboratory	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Practical R : Research C: Credits
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: To make the students to understand the Airframe components and the tools used to maintain the components. Defect investigation, methods to carry out investigation and the detailed maintenance and practice procedures.

COURSE OUTCOMES (COs) : The students will be able to

CO1	Illustrate the usage of Inspection and Maintenance Tools. (Level 2)
CO2	Explain various Defects in Airframe. (Level 2)
CO3	Explain the repairing procedures of Airframe defects. (Level 3)
CO4	Describe about the inspection of Engine components. (Level 3)
CO5	Illustrate Overhauling procedure of Aero Engine. (Level 2)

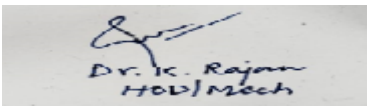
Mapping of Course with Program Outcomes (Pos)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3			3		3					3
CO2	3	3			3		3	3				3
CO3	3	3	3		3		3		3			3
CO4	3	3			3		3	3				3
CO5	3	3	3		3		3					3

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	2	2	1				
CO2	3	2	2	1				
CO3	3	2	2	1				
CO4	3	2	2					
CO5	3	2	2	1				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							



Subject Code: BAE20E13	Subject Name : AERO ENGINE MAINTENANCE AND REPAIR	Ty/Lb/ETL	L	T/SLr	P/R	C
	Prerequisite: Aircraft Systems,Aero Engine and Airframe laboratory	Ty	3	0/0	0/0	3

UNIT I PISTON ENGINES **9**

Carburetion and Fuel injection systems for small and large engines - Ignition system components -spark plug detail - Engine operating conditions at various altitudes - Engine power measurements -Classification of engine lubricants and fuels - Induction, Exhaust and cooling system - Maintenance and inspection check to be carried out.Inspection and maintenance and trouble shooting - Inspection of all engine components - Daily and routine checks - Overhaul procedures - Compression testing of cylinders - Special inspection schedules - Engine fuel, control and exhaust systems - Engine mount and super charger - Checks and inspection procedures.

UNIT II PROPELLERS **9**

Propeller theory - operation, construction assembly and installation - Pitch change mechanism-Propeller axially system- Damage and repair criteria - General Inspection procedures - Checks on constant speed propellers - Pitch setting, Propeller Balancing, Blade cuffs, Governor/Propeller operating conditions - Damage and repair criteria.

UNIT III JET ENGINES **9**

Types of jet engines - Fundamental principles - Bearings and seals - Inlets - compressors- turbines-exhaust section - classification and types of lubrication and fuels- Materials used - Details of control, starting around running and operating procedures - Inspection and Maintenance- permissible limits of damage and repair criteria of engine components- internal inspection of engines- compressor washing- field balancing of compressor fans- Component maintenance procedures - Systems maintenance procedures - use of instruments for online maintenance - Special inspection procedures-Foreign Object Damage - Blade damage .

UNIT IV TESTING AND INSPECTION **9**

Symptoms of failure - Fault diagnostics - Case studies of different engine systems - Rectification during testing equipments for overhaul: Tools and equipments requirements for various checks and alignment during overhauling - Tools for inspection - Tools for safety and for visual inspection -Methods and instruments for non destructive testing techniques - Equipment for replacement of parts and their repair. Engine testing: Engine testing procedures and schedule preparation - Online maintenance.

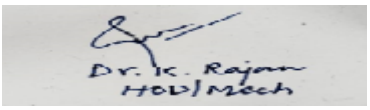
UNITV OVERHAULING **9**

Engine Overhaul - Overhaul procedures - Inspections and cleaning of components - Repairs schedules for overhaul - Balancing of Gas turbine components. Trouble Shooting: Procedures for trouble shooting - Condition monitoring of the engine on ground and at altitude - engine health monitoring and corrective methods.

Total No. of Periods: 45

REFERENCES:

1. Kroes & Wild," Aircraft Power plants ", 7th Edition - McGraw Hill, New York, 1994.
2. Turbomeca," Gas Turbine Engines ", The English Book Store", New Delhi, 1993.
3. United Technologies Pratt & Whitney, "The Aircraft Gas turbine Engine and its Operation", The English Book Store, New Delhi.



Subject Code: BAE20E14	Subject Name : AIR TRAFFIC CONTROL AND PLANNING	Ty/ Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Air line and airport Management	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Practical R : Research C: Credits
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn
Understanding the requirement of Air Traffic control systems, knowledge in flight information system and rules of Air traffic systems

COURSE OUTCOMES (COs) : The students will be able to

CO1	Understand the basic principles of Air Traffic Management (Level 2)
CO2	Understanding the requirements of Air traffic control system and its types.(Level 2)
CO3	Knowledge in Flight Information System and rules of Traffic system(Level 3)
CO4	Study Aerodrome and Runway Concepts. (level 6)
CO5	Knowledge indirection indicator systems for air navigation. (Level 3)

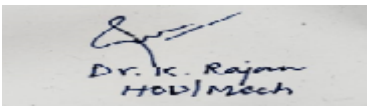
Mapping of Course with Program Outcomes (Pos)

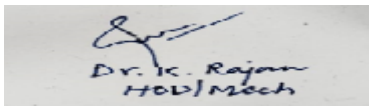
Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	3	3	2	1	3	3		2
CO2	3	2	3	3	3	3	2	1	3	3		2
CO3	3	2	3	3	3	3	2	1	3	3		2
CO4	3	2	3	3	3	3	2	1	3	3		2
CO5	3	2	3	3	3	3	2	1	3	3		2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	2	2					
CO2	3	2	2					
CO3	3	2	2					
CO4	3	2	2					
CO5	3	2	2					

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			




Dr. K. Rajan
HOD/Mech

Subject Code: BAE20E14	Subject Name : AIR TRAFFIC CONTROL AND PLANNING	Ty/Lb/ETL	L	T/SLr	P/R	C
	Prerequisite: Air line and airport Management	Ty	3	0/0	0/0	3

UNIT I BASIC CONCEPTS **9**

Objectives of air traffic control systems - Parts of ATC services - Scope and Provision of ATCs - VFR & IFR operations - Classification of ATS air spaces - Various kinds of separation - Altimeter setting procedures - Establishment, designation and identification of units providing ATS - Division of responsibility of control.

UNIT II AIR TRAFFIC SYSTEMS **9**

Area control service, assignment of cruising levels - minimum flight altitude - ATS routes and significant points - RNAV and RNP - Vertical, lateral and longitudinal separations based on time / distance -ATC clearances - Flight plans - position report

UNIT III FLIGHT INFORMATION SYSTEMS **10**

Radar service, Basic radar terminology - Identification procedures using primary / secondary radar - performance checks - use of radar in area and approach control services - assurance control and coordination between radar / non radar control - emergencies - Flight information and advisory service - Alerting service - Co-ordination and emergency procedures - Rules of the air.

UNIT IV AERODROME DATA **9**

Aerodrome data - Basic terminology - Aerodrome reference code - Aerodrome reference point -Aerodrome elevation - Aerodrome reference temperature - Instrument runway, physical Characteristics; length of primary / secondary runway - Width of runways - Minimum distance between parallel runways etc. - obstacles restriction.

UNIT V NAVIGATION AND OTHER SERVICES **8**

Visual aids for navigation Wind direction indicator - Landing direction indicator - Location and characteristics of signal area - Markings, general requirements - Various markings - Lights, general requirements - Aerodrome beacon, identification beacon - Simple approach lighting system and various lighting systems - VASI & PAPI - Visual aids for denoting obstacles; object to be marked and lighter - Emergency and other services.

Total No. of Periods: 45

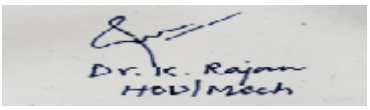
TEXT BOOK

1. AIP (India) Vol. I & II, "The English Book Store", 17-1, Connaught Circus, New Delhi.

REFERENCES

1."Aircraft Manual (India) Volume I", latest Edition - The English Book Store, 17-1, Connaught Circus, New Delhi.

2."PANS - RAC - ICAO DOC 4444", Latest Edition, The English Book Store, 17-1, Connaught Circus, New Delhi



Subject Code: BAE 20E15	Subject Name : AIRCRAFT PERFORMANCE	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Propulsion I &II ,Aircraft Stability and control	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Practical R : Research C: Credits
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn
The concepts and necessary equations to assess the performance of aircraft

COURSE OUTCOMES (COs) : The students will be able to

CO1	Draw and develop the drag polar diagram and associated equation for subsonic airplane
CO2	Calculate, under given operating condition, the range and endurance of jet and propeller airplane
CO3	Assess the performance of the airplane during steady glide and glimp
CO4	Analyze the factors for take off and landing distance
CO5	Draw the flight envelope of the given aircraft

Mapping of Course with Program Outcomes (Pos)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3		3			3		2
CO2	3	3	3	3	3		3			3		2
CO3	3	3	3	3	3		3			3		2
CO4	3	3	3	3	3		3			3		2
CO5	3	3	3	3	3		3			3		2

Cos / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**				
CO1	3			2				
CO2	3	3		2				
CO3	3	3		2				
CO4	3	3		2				
CO5	3	3		2				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
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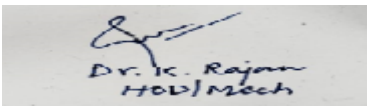


Subject Code: BAE 20E15	Subject Name : AIRCRAFT PERFORMANCE	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Propulsion I &II ,Aircraft Stability and control	**Ty**	**3**	**0/0**	**0/0**	**3**

UNITI GENERAL CONCEPTS **9**

International Standard atmosphere, IAS, EAS, TAS, Propeller theory- Froude momentum and blade element theories, Propeller co-efficients, Use of propeller charts, Performance of fixed and variable pitch propellers, High lift devices, Thrust augmentation.

UNITII DRAGOF BODIES **9**

Streamlined and bluff body, Types of drag, Effect of Reynold's number on skin friction and pressure drag, Drag reduction of airplanes, Drag polar, Effect of Mach number on drag polar. Concept of sweep- effect of sweep on drag

UNITIII STEADY LEVEL FLIGHT **9**

General equation of motion of an airplane. Steady level flight, Thrust required and Power required, Thrust available and Power available for propeller driven and jet powered aircraft, Effect of altitude, maximum level flight speed, conditions for minimum drag and minimum power required, Effect of drag divergence on maximum velocity, Range and Endurance of Propeller and Jet aircrafts. Effect of wind on range and endurance.

UNITIV GLIDING ANDCLIMBINGFLIGHT **9**

Shallow and steep angles of climb, Rate of climb, Climb hodograph, Maximum Climb angle and Maximum Rate of climb- Effect of design parameters for propeller jet and glider aircrafts, Absolute and service ceiling, Cruise climb, Gliding flight, Glidehodograph.

UNITV ACCELERATED FLIGHT **9**

Estimation of take-off and landing distances, Methods of reducing landing distance, level turn, minimum turn radius, maximum turn rate, bank angle and load factor, Constraints on load factor, SST and MSTR. Pull up and pull down maneuvers, V-n diagram.

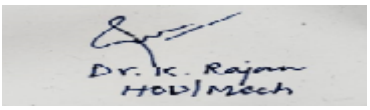
Total No. of Periods: 45

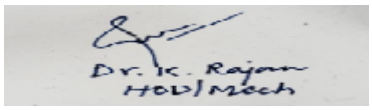
TEXT BOOKS:

1. Anderson, Jr., J.D. Aircraft Performance and Design, McGraw-Hill International Edition, 1999.
2. Houghton,E.L. and Carruthers, N.B. Aerodynamics for engineering students, Edward Arnold Publishers,1988.

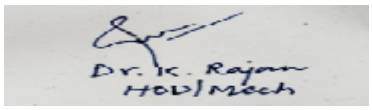
REFERENCES:

1. *J.D. Anderson, Introduction to Flight, McGraw-Hill; 8th edition ,2015*
2. *L.J. Clancy, Aerodynamics, Shroff publishers(2006)*
3. *John J Bertin., Aerodynamics for Engineers, Prentice Hall; 6th edition,2013.*
4. *A.M. Kuethe and C.Y. Chow, Foundations of Aerodynamics, John Wiley & Sons; 5th Edition,1997*




Dr. K. Rajan
HOD/Mech

ELECTIVE- IV



Subject Code: BAE 20E16	Subject Name : HYPERSONIC AERODYNAMICS	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Aerodynamics I &II	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Practical R : Research C: Credits
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: To introduce fundamental concepts and features peculiar to hypersonic flow to students to familiarize them with the aerodynamical aspects of hypersonic vehicles and the general hypersonic flow theory.

COURSE OUTCOMES (COs) : The students will be able to

CO1	Apply the basic concepts of hypersonic aerodynamics to hypersonic Internal/External flow fields (Level 3)
CO2	Establish the properties of inviscid hypersonic flows using surface inclination and approximate methods. (Level 4)
CO3	Establish the boundary layer equations for hypersonic flow (Level 3)
CO4	Analyze the properties of hypersonic shockwaves and boundary layer interactions in hypersonic flow. (Level 4)
CO5	Apply High-temperature gas dynamics to hypersonic Internal/External flow fields. (Level 3)

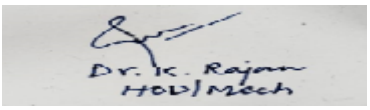
Mapping of Course with Program Outcomes (Pos)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			2							3	
CO2	3		2									
CO3	3	2									2	
CO4	3			1								
CO5	3	3									3	

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3			2				
CO2			3					
CO3	2			2				
CO4	3							
CO5			2					

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							



Subject Code: BAE 20E16	Subject Name : HYPERSONIC AERODYNAMICS	Ty/Lb/ETL	L	T/SLr	P/R	C
	Prerequisite: Aerodynamics I &II	Ty	3	0/0	0/0	3

UNIT I FUNDAMENTALS OF HYPERSONIC AERODYNAMICS **9**

Introduction to hypersonic aerodynamics - differences between hypersonic aerodynamics and supersonic aerodynamics - concept of thin shock layers and entropy layers - hypersonic flight paths - hypersonic similarity parameters - shock wave and expansion wave relations of inviscid hypersonic flows.

UNIT II SIMPLE SOLUTION METHODS FOR HYPERSONICINVISCID FLOWS **9**

Local surface inclination methods - Newtonian theory - modified Newtonian law - tangent wedge and tangent cone and shock expansion methods - approximate methods - hypersonic small disturbance theory - thin shock layer theory.

UNIT III VISCOUS HYPERSONIC FLOW THEORY **9**

Boundary layer equations for hypersonic flow - hypersonic boundary layers - self similar and non self similar boundary layers - solution methods for non self similar boundary layers - aerodynamic heating and its adverse effects on airframe.

UNIT IV VISCOUS INTERACTIONS IN HYPERSONIC FLOWS **9**

Introduction to the concept of viscous interaction in hypersonic flows - Strong and weak viscous interactions - hypersonic viscous interaction similarity parameter - introduction to shock wave boundary layer interactions.

UNIT V HIGH TEMPERATURE EFFECTS in HYPERSONIC FLOWS **9**

Nature of high temperature flows - chemical effects in air - real and perfect gases - Gibb's free energy and entropy - chemically reacting boundary layers - recombination and dissociation.

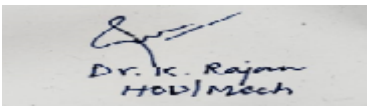
Total No. of Periods: 45

TEXT BOOKS:

1. John D. Anderson. Jr., "Hypersonic and High Temperature Gas Dynamics", McGraw hill Series, New York, 1996.

REFERENCES:

1. *John D. Anderson. Jr., "Modern Compressible flow with historical Perspective", McGraw Hill Publishing Company, New York, 1996.*
2. *John T. Bertin, "Hypersonic Aerothermodynamics", published by AIAA Inc., Washington. D.C., 1994.*



Subject Code: BAE 20E17	Subject Name : EXPERIMENTAL AERODYNAMICS	Ty/Lb/ ETL	L	T/ SLr	P/R	C
	Prerequisite: Fluid Mechanics ,Fundamentals of aircraft control and Instrumentation system	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Practical R : Research C: Credits
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: To provide details, operating principles and limitations of forces, pressure, velocity and temperature measurements. To describe flow visualization techniques and to highlight in depth discussion of analog methods.

COURSE OUTCOMES (COs) : The students will be able to

CO1	Analyze the basic principles in fluid measurements. (Level 4)
CO2	Measure data using wind tunnel balances. (Level 5)
CO3	Analyze the basic principles of flow visualization techniques. (Level 4)
CO4	Do various measurements of pressure, velocity and temperature parameters. (Level 5)
CO5	Use data acquisition system for experiments. (Level 3)

Mapping of Course with Program Outcomes (Pos)

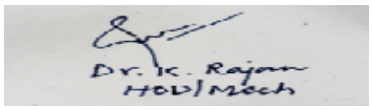
Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		3								3
CO2	3	3		3								3
CO3	3	3		3								3
CO4	3	3		3								3
CO5	3	3		3								3

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3		2				
CO2	2	3		3				
CO3	3	2		3				
CO4	3	3		2				
CO5	2	3		3				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Cate	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			

Dr. K. Rajan
HOD/Mech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HOD/Mech

Subject Code: BAE 20E17	Subject Name : EXPERIMENTAL AERODYNAMICS	Ty/Lb/ETL	L	T/SLr	P/R	C
	Prerequisite: Fluid Mechanics ,Fundamentals of aircraft control and Instrumentation system	**Ty**	**3**	**0/0**	**0/0**	**3**

UNIT I BASIC MEASUREMENTS IN FLUID MECHANICS **7**

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.

UNIT II CHARACTERISTICS OF MEASUREMENTS **10**

Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels - Power losses in a wind tunnel - Instrumentation of wind tunnels - Turbulence- Wind tunnel balance - principles, types and classifications -Balance calibration.

UNIT III FLOW VISUALIZATION AND ANALOGUE METHODS **9**

Principles of Flow Visualization - Hele-Shaw apparatus - Interferometer - Fringe-Displacement method - Schlieren system - Shadowgraph - Hydraulic analogy - Hydraulic jumps - Electrolytic tank

UNIT IV PRESSURE, VELOCITY AND TEMPERATURE MEASUREMENTS **9**

Measurement of static and total pressures in low and high speed flows- Pitot-Static tube characteristics - Pressure transducers - principle and operation - Velocity measurements - Hot-wire anemometry - LDV - PIV: Temperature measurements.

UNITV SPECIAL FLOWS AND UNCERTAINTY ANALYSIS **10**

Experiments on Taylor-Proudman theorem and Ekman layer - Measurements in boundary layers -Data acquisition and processing - Signal conditioning - Uncertainty analysis - Estimation of measurement errors - External estimate of the error - Internal estimate of the error - Uncertainty calculation - Uses of uncertainty analysis.

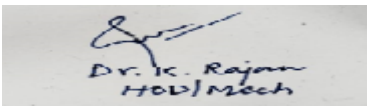
Total No. of Periods: 45

TEXT BOOKS:

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.

REFERENCES:

1. *Pope, A., and Goin, L, "High Speed Wind Tunnel Testing", John Wiley, 1985.Bradsaw Experimental Fluid Mechanics.*
2. *NAL-UNI Lecture Series 12: Experimental Aerodynamics, NAL SP 98 01 April 1998*
Lecture course on "Advanced Flow diagnostic techniques" 17-19 September 2008 NAL, Bangalore



Subject Code: BAE 20E18	Subject Name : ROCKETS AND MISSILES	Ty/Lb /ETL	L	T/ SLr	P/R	C
	Prerequisite: Aerdynamics I&II,Propulsion I&II.	Ty	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Practical R : Research C: Credits
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

On important topics like rocket motion, rocket aerodynamics and staging & control of rockets to students to enrich their knowledge in the area of missile.

COURSE OUTCOMES (COs) : The students will be

CO1	Understanding about the types of Rockets and Missiles (Level 2)
CO2	Understanding the aerodynamics of Rockets and Missiles (Level 2)
CO3	Applying and understanding the concepts behind Rocket motion in free space and gravitational space (Level 3)
CO4	Analyzing the design philosophy in staging of Rockets and Missiles (Level 4)
CO5	Analyzing the various aerodynamic characteristics and control methods of Rockets and Missiles (Level 4)

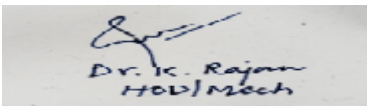
Mapping of Course with Program Outcomes (Pos)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	3	2	1	2	2	1	2	1	2	2
CO2	3	2	3	2	1	2	2	1	2	1	2	2
CO3	3	3	3	2	2	2	2	1	2	2	2	2
CO4	3	3	3	2	2	2	2	1	2	2	2	2
CO5	3	3	3	2	2	2	2	1	2	2	2	2

Cos / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**				
CO1	3	2	2	2				
CO2	3	2	2	2				
CO3	3	3	2	2				
CO4	3	3	2	2				
CO5	3	3	2	2				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							



Subject Code: BAE 20E18	Subject Name : ROCKETS AND MISSILES	Ty/Lb /ETL	L	T/ SLr	P/R	C
	Prerequisite: Aerdynamics I&II,Propulsion I&II.	Ty	**3**	**0/0**	**0/0**	**3**

UNIT I CLASSIFICATION OF ROCKETS AND MISSILES **9**

Various methods of classification of missiles and rockets - Basic aerodynamic characteristics of surface to surface, surface to air, air to surface and air to air missiles - Examples of various Indian space launch vehicles and missiles - Current status of Indian rocket programme with respect to international scenario

UNIT IIAERODYNAMICS OF ROCKETS AND MISSILES **10**

Airframe components of rockets and missiles - forces acting on a missile while passing through atmosphere - classification of missiles - slender body aerodynamics - method of describing forces and moments - lift force and lateral moment -lateral aerodynamic damping moment - longitudinal moment - drag estimation - upwash and downwash in missile bodies - rocket dispersion.

UNIT IIIROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD **10**

One dimensional and two-dimensional rocket motions in free space and homogeneous gravitational fields - description of vertical, inclined and gravity turn trajectories - determination of range and altitude - simple approximations to determine burn out velocity and altitude - estimation of culmination time and altitude.

UNIT IV STAGING OF ROCKETS AND MISSILES **8**

Design philosophy behind multistaging of launch vehicles and ballistic missiles - optimization of multistage vehicles - stage separation techniques in atmosphere and in space - stage separation dynamics and lateral separation characteristics -

UNIT V CONTROL OF ROCKETS AND MISSILES **8**

Introduction to aerodynamic and jet control methods - various types of aerodynamic control methods for tactical and short range missiles- aerodynamic characteristics - various types of thrust vector control methods including secondary injection thrust vector control for launch vehicles and ballistic missiles -.

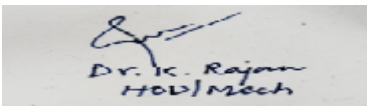
Total No. of Periods: 45

TEXT BOOKS:

1. Cornelisse, J.W., "Rocket Propulsion and Space Dynamics", J.W. Freeman & Co., Ltd, London, 1982
2. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edition, 1993.

REFERENCES:

1. Parker, E.R., "Materials for Missiles and Spacecraft", McGraw Hill Book Co. Inc. 1982.
Mathur, M.L., and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers and Distributors, Delhi, 1988



Subject Code: BAE20E19	Subject Name : STRUCTURAL DYNAMICS	Ty/Lb/ ETL	L	T/ S.Lr	P/R	C
	Prerequisite:Aircraft Structures	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Practical R : Research C: Credits

Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: To study the effect of periodic and periodic forces on mechanical systems with matrix approach and also to get the natural characteristics of large sized problems using approximate methods.

COURSE OUTCOMES (COs) : The students will be able to

CO1	Understand the basic principles constraints and generalized coordinates Virtual work andforce - deflection influence functions - stiffness and flexibility methods. (Level 2)
CO2	Apply the free and forced vibrations of systems with finite degrees of freedom. (Level 3)
CO3	Analyzing various matrix method sand modal analysis.(Level 1)
CO4	Study the different methods to analyze the vibration of component. (Level 4)
CO5	Determine the approximate methods to evaluating the Eigen frequencies and vectors by reduced subspace. (Level 5)

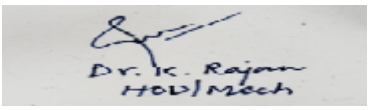
Mapping of Course with Program Outcomes (Pos)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	3	1	1	1	2	1	2	1	2	1
CO2	2	3	3	2	2	1	2	1	2	2	2	2
CO3	2	3	3	2	2	1	2	1	2	2	2	2
CO4	2	3	3	2	2	1	2	1	2	2	2	2
CO5	2	3	3	2	2	1	2	1	2	2	2	2

Cos / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**				
CO1	3	2	3	2				
CO2	3	2	3	2				
CO3	3	2	3	2				
CO4	3	2	3	2				
CO5	3	2	3	2				

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							



Subject Code: BAE20E19	Subject Name : STRUCTURAL DYNAMICS	Ty/Lb/ ETL	L	T/ S.Lr	P/R	C
	Prerequisite:Aircraft Structures	Ty	3	0/0	0/0	3

UNIT I FORCE DEFLECTION PROPERTIES OF STRUCTURES 9

Constraints and Generalized coordinates - Virtual work and generalized forces - Force - Deflection influence functions - stiffness and flexibility methods.

UNIT II PRINCIPLES OF DYNAMICS 9

Free and forced vibrations of systems with finite degrees of freedom - Response to periodic excitation - Impulse Response Function - Convolution Integral

UNIT III NATURAL MODES OF VIBRATION 9

Equations of motion for Multi degree of freedom Systems - Solution of Eigen value problems - Normal coordinates and orthogonality Conditions. Modal Analysis.

UNIT IV ENERGY METHODS 9

Rayleigh's principle - Rayleigh - Ritz method - Coupled natural modes - Effect of rotary inertia and shear on lateral vibrations of beams - Natural vibrations of plates.

UNITV APPROXIMATE METHODS 9

Approximate methods of evaluating the Eigen frequencies and eigen vectors by reduced, subspace, Lanczos, Power, Matrix condensation and QR methods.

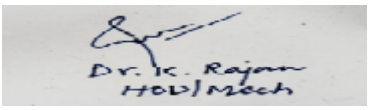
Total No. of Periods: 45

TEXT BOOKS:

1. Tse. F.S., Morse. I.E. and Hinkle. H.T., "Mechanical Vibrations: Theory and Applications" , Prentice Hall of India Pvt. Ltd, New Delhi, 2004.
2. Hurty. W.C. and M.F. Rubinstein, "Dynamics of Structures", Prentice Hall of India Pvt. Ltd., New Delhi 1987.

REFERENCES:

1. *Vierck. R.K., "Vibration Analysis", 2nd Edition, Thomas Y. Crowell & Co Harper & Row Publishers, New York, U.S.A. 1989.*
2. *Timoshenko. S.P., and D.H. Young, "Vibration Problems in Engineering", John Willey & Sons Inc., 1984.*
3. *Ramamurthi. V., "Mechanical Vibration Practice and Noise Control" Narosa Publishing House Pvt. Ltd, 2008.*



Subject Code: BAE20E20	Subject Name : CONTROL ENGINEERING	Ty/Lb/ETL	L	T/SLr	P/R	C
	Prerequisite:Mathematics I,II &III.	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Practical R : Research C: Credits

Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES: The student will learn

To apply mathematical knowledge to model the systems and analysze the frequency domain

COURSE OUTCOMES (COs) : The students will be able to

CO1	Apply mathematical knowledge to model the system (Level 3)
CO2	Analyse the frequency domain(Level 4)
CO3	To check the stability of time and frequency domain. (Level 5)
CO4	Identify the concept and construction of stability(Level 1)
CO4	Understand various Control system(Level 2)

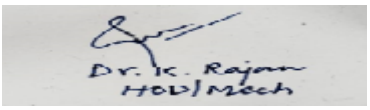
Mapping of Course with Program Outcomes (Pos)

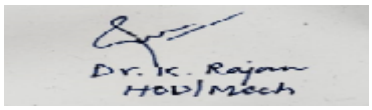
Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2			1		2
CO2	3	3	3	3	3	2	2			1		2
CO3	3	3	3	3	3	2	2			1		2
CO4	3	3	3	3	3	2	2			1		2
CO5	3	3	3	3	3	2	2			1		2

Cos / PSOs	PSO1	PSO2	PSO3	PSO4				
CO1	3	3	2					
CO2	3	3	2					
CO3	3	3	2					
CO4	3	3	2					
CO5	3	3	2					

3/2/1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			

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HOD/Mech

Subject Code: BAE20E20	Subject Name : CONTROL ENGINEERING	Ty/Lb/ETL	L	T/ SLr	P/R	C
	Prerequisite:Mathematics I,II &III.	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION **9**

Historical review, Simple pneumatic, hydraulic and thermal systems, Series and parallel system, Analogies, mechanical and electrical components, Development of flight control systems.

UNIT II OPEN AND CLOSED LOOP SYSTEMS **9**

Feedback control systems - Control system components - Block diagram representation of control systems, Reduction of block diagrams, Signal flow graphs, Output to input ratios.

UNIT III CHARACTERISTIC EQUATION AND FUNCTIONS **9**

Laplace transformation, Response of systems to different inputs viz., Step impulse, pulse, parabolic and sinusoidal inputs, Time response of first and second order systems, steady state errors and error constants ofunity feedback circuit.

UNIT IV CONCEPT OF STABILITY **9**

Necessary and sufficient conditions, Routh-Hurwitz criteria of stability, Root locus and Bode techniques, Concept and construction, frequency response.

UNITV SAMPLED DATA SYSTEMS **9**

Z-Transforms Introduction to digital control system, Digital Controllers and Digital PID controllers

Total No. of Periods: 45

TEXT BOOKS:

1. OGATO, Modern Control Engineering, Prentice-Hall of India Pvt. Ltd., New Delhi, 1998.
2. Azzo, J.J.D. and C.H. Houpis Feed back control system analysis and synthesis, McGraw-Hill international3rs Edition, 1998.

REFERENCES:

1. *Kuo, B.C. "Automatic control systems", Prentice-Hall of India Pvt. Ltd., New Delhi, 1998.*
2. *Houpis, C.H. and Lamont, G.B. "Digital control Systems", McGraw Hill Book co., New York, U.S.A. 1995.*
3. *Naresh KSinha, "Control Systems", New Age International Publishers, New Delhi, 1998.*

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