HONORS IN AIRCRAFT STRUCTURE
B.Tech 3rd Semester

B. Tech. IIIrd Sem Aeronautical Engineering				
BAE32325: Smart Materials and structures				
Teaching Scheme			**Examination Scheme**	
Lectures	**3hr/week**		**CIE**	40 Marks
Tutorials	-		**ESE**	60 Marks
Practical	-		**Total**	100 Marks
Total Credits	3		Duration of Exam: 3 Hours	

The Objectives of this course are:

1	To get familiarize the smart materials and its role in developing intelligent systems
2	To arrive at the shock wave and expansion wave relations.
3	To get exposure on potential equation for 2-dimensional compressible flow.
4	To get knowledge on high-speed flow over airfoils, wings and airplane configuration.
5	To gain basic knowledge on low and high-speed wind tunnels and model testing.

Course Contents

Unit I	Introduction to Smart Materials: What is Intelligence? Artificial intelligence Vs. embedded Intelligence, Definition of smart material, need for smart materials, classifications of smart systems, components of a smart systems, smart system applications, the role of Smart Materials in developing Intelligent Systems and Adaptive Structures
Unit II	**Piezoelectric Materials** -— constitutive relationship, electromechanical coupling coefficients, piezoelectric constants, piezoceramic materials, variation of coupling coefficients in hard and soft piezoceramics, polycrystalline vs single crystal piezoelectric materials, polyvinyldene fluoride, piezoelectric composites. **Magnetostrictive Materials** — constitutive relationship, magneto-mechanical coupling coefficients, Joule Effect, Villari Effect, Matteuci Effect, Wiedemann effect, Giant magnetostriction in Terfenol- D, Terfenol-D particulate composites, Galfenol and Metglas materials.
Unit III	**Shape Memory Alloys (SMA) —** Introduction, Phenomenology, Influence of stress on characteristic temperatures, Modelling of shape memory effect. Vibration control through shape memory alloys. Design considerations, multiplexing embedded NiTiNOL actuators. Electro-active Polymers (EAP)- Introduction, Phenomenology, Influence of stress on characteristic temperatures

Unit IV	**Smart Actuators** Piezoelectric Actuators — Induced Strain actuation model, Unimorph and Bimorph Actuators, Actuators embedded in composite laminate, Impedance matching in actuator design, Feedback Control, Pulse Drive, Resonance Drive. Magnetostrictive Actuators — Magnetostrictive Mini Actuators, Thermal instabilities, Discretely distributed actuation, Manetostrictive Composites. Shape Memory Alloy based actuators for Shape Control, Electro-active Polymers for Work-Volume Generation
Unit V	**Smart Sensors:** Piezoelectric Sensors Magnetostrictive Sensors Techniques of Self Sensing MEMS Sensors. Sensors based on LBHS Smart Materials - EAP based sensors, SMA based encoders, Optical Fibre based Sensing. visualization methods of subsonic and supersonic flows.

Text Books	
1	M.V. Gandhi, B.D. Thompson" Smart Materials and Structures" Springer Science & Business Media, 31-May-1992.
Reference Books	
1	Brian Culshaw, Smart Structures and Materials, Artech House, 2000.
2	Gauenzi, P., Smart Structures, Wiley, 2009.
3	Cady, W. G., Piezoelectricity, Dover Publication
Useful Links	
1	https://nptel.ac.in/courses/101/101/101101079/
2	https://nptel.ac.in/courses/101/105/101105059/
3	https://onlinecourses.nptel.ac.in/noc19_ae05/preview

BAE32325	Course Outcomes	CL	Class Sessions
CO1	**Identify** and describe the core components of smart systems and explain their integration into functional systems.	3	9
CO2	**Apply** knowledge of composite materials (e.g., piezoelectric and magnetostrictive composites) in real-world engineering applications.	3	9
CO3	**Analyze** the use of SMAs in vibration control and actuation, particularly with NiTiNOL actuators.	4	9
CO4	**Ilustrate** feedback control methods, pulse drive, and resonance drive techniques in piezoelectric actuator systems.	3	9
CO5	**Illustrate** visualization methods used for subsonic and supersonic flow sensing.	3	9

MINORS IN DRONE TECHNOLOGY

B.Tech 3rd Semester

Second Year (Semester-III) B. Tech. Aeronautical Engineering				
BAE32321: Introduction to Aeronautical Engineering				
2nd Year- (3rd Semester)				
Teaching Scheme			**Examination Scheme**	
Lectures	3 Hr / Week		**ESE**	60 Marks
Tutorial	-		**CIE**	40 Marks
Practical	-		**Total**	100 Marks
Theory Credits :3			**Duration of Exam :**3 Hours	

Course Objectives	
The Objectives of this course is:	
1.	To make students aware about the aircraft design process and its purpose.
2.	To make the student configuration of fuselage and wings.
3.	To investigate the performance and stability characteristics of airplanes.
4.	To the study different aircrafts engines and their applications.

Course Contents	
Unit-I	**Introduction and developments** Pre Wright-Brothers era, Wright Flyer, history and evaluation of aircraft. Conventional airplane, progress in airplane design and application, Current status. Other kinds of heavier than air vehicle, helicopter, VSTOL machines, space vehicles, reusable space vehicles and space shuttle, Developments in aerodynamics, materials, structures and propulsion over the years.
Unit-II	**Aircraft Configurations and Aircraft Systems** Components of an airplane and their functions, Different parts of airplane. Different types of flight vehicles, classifications. Conventional control, Powered control, Basic instruments for flying, Typical systems for control actuation. **Aircraft Systems:** Elementary studies on hydraulic, pneumatic, pressurizing air- conditioning and oxygen systems. Landing gear and control surface actuating system. Aircraft electrical systems, elementary studies of generation and on-board distribution of electricity.
Unit-III	**Introduction to Aerodynamics** Aerofoil nomenclature; Flow over aerofoil; Lift and generation of lift by Bernoulli's principle; Lift and drag components – generation of lift and drag; lift curve, drag curve, types of drag, factors affecting lift and drag; variation of lift with angle of attack, pressure distribution over aerofoil; centre of pressure and its significance; aerodynamic centre, aspect ratio, velocity of sound, Mach number and supersonic flight effects, wing span, wing area, sweep, tapered ratio, dihedral, anhedral angle.

Unit-IV	**Airplane Structures:** Configuration of fuselage and wings, progress in materials: wooden to all metal airplanes, strength to weight ratio of aircraft materials, importance of weight load factors, factors of safety in aeronautics and aerospace applications. Details of the structural layout of wing, fuselage tail planes. Cockpit and cabin configuration. Different types of materials for airplane andengine application. Materials for space vehicles.
Unit-V	**Introduction to Aircraft Propulsion** Difference between air-breathing and non-air-breathing engines, classification of aircraft based on power plant, location and principle operation, basics of piston engine, classification of aircraft engines, Brayton cycle and its application to the gas turbine engines characteristics of turbofan, turbojet, turbo prop, ramjet and scramjet engines, classification combustion chamber, types of fuel used in commercial aircraft engines, principle operation of aircraft engines.

Text Books	
1	John D. Anderson, Jr., "Introduction to Flight", Mc-Graw Hill, 3rd edition, 1995.
2	Lalit Gupta and O P Sharma, Fundamentals of Flight, Vol-I to Vol-IV, Himalayan Books, 1st edition,2006.
3	John D. Anderson, Jr., "The Airplane - History of its Technology", AIAA Series, 1st edition, 2002.
Reference Books	
1	G. P. Sutton, O.Biblarz,"Rocket Propulsion Elements", John Wiley & Sons, 7th edition, 2001.
2	A. C. Kermode, "Flight without Formulae", Pearson Education, 5th edition, 2004.
3	S. K. Ojha, "Flight Performance of Aircraft", AIAA Series, 1st edition, 1995.
	Useful Links
1	https://nptel.ac.in/courses/101/101/101101079/
2	https://nptel.ac.in/courses/101/105/101105059/
3.	https://nptel.ac.in/courses/101/105/101105031/

BAE32321	Course Outcomes	CL	Class Sessions
CO1	**Understand history** of aviation and basic concepts of aerospace engineering and implement the knowledge acquired in design and development of aircrafts.	2	9
CO2	**Understand** different components of aircraft, vehicle types and flight instrumentations and develop conceptual design of aircraft systems and subsystems.	2	9
CO3	**Apply** the knowledge of wing characteristics (wing span, sweep, taper ratio, dihedral/anhedral angles) to explain their impact on aerodynamic performance.	3	9
CO4	**Apply** the knowledge of aircraft structures and configurations in solving the problems on airplane layouts, load factor and factor of safety.	3	9
CO5	**Compare** the characteristics and applications of turbofan, turbojet, turboprop, ramjet, and scramjet engines.	3	9