TULSIRAMJI GAIKWAD-PATIL
College of Engineering & Technology
Mohgaon, Wardha Road, Nagpur - 441 108

DEPARTMENT OF AERONAUTICAL ENGINEERING

Structure & Curriculum

From

Academic Year 2023-24

Institute Vision & Mission

Vision:

- To emerge as a learning Center of Excellence in the National Ethos in domains of Science, Technology and Management.

Mission:

- To strive for rearing standard and stature of the students by practicing high standards of professional ethics, transparency and accountability.
- To provide facilities and services to meet the challenges of Industry and Society.
- To facilitate socially responsive research, innovation and entrepreneurship.
- To ascertain holistic development of the students and staff members by inculcating knowledge and profession as work practices.

Program Outcomes (POs)

1. Engineering Knowledge
2. Problem Analysis
3. Design/development of solutions
4. Conduct investigations of complex problems
5. Modern tool usage
6. The engineer and society
7. Environment and sustainability
8. Ethics
9. Individual and team work
10. Communication
11. Project management and finance
12. Lifelong learning

Department Vision & Mission

Vision:

- To foster technically skilled Aeronautical Engineers of the utmost academic principles, to convene the needs of academia, industry and society.

Mission:

- Impart quality technical education and unique interdisciplinary experiences.
- Develop the analytical, computational and design capabilities to provide sustainable solutions.
- Expose the students to the current trends and opportunities in the Aerospace industry.
- Inculcate professional responsibility based on an innate ethical value system.

Program Educational Objectives (PEOs)

1. Under graduate students will acquire knowledge to investigate and solve Aeronautical Engineering problems using basics of applied science and engineering.
2. Under graduate students will utilize the modern technology and techniques to explore new skills and ideas to satisfy the need of society as well as industry.
3. Under graduate students will get finest employment opportunities in the field of Aeronautical Engineering.
4. To develop the environment of societal and ethical values to concern with engineering issues.
5. Under graduate students will contribute in the domain specific and inter disciplinary research through the project based learning.

Program Specific Outcomes (PSO)

- Develop profound working knowledge to solve combination of complex problems in aerodynamics, propulsion, structures, flight mechanics and allied courses.
- Be equipped to use CAE packages, simulation languages and advanced tools to solve practical design and analysis problems.
- Under graduates will be able to utilize the extensive knowledge of design, manufacturing, testing or maintenance of systems and subsystems to pursue career in aeronautical engineering.

Head Of Department
Aeronautical Engineering
Tulsiramji Gaikwad- Patil
College Of Engineering And
Technology, Nagpur

Dean Academics
Tulsiramji Gaikwad-Patil
College Of Engineering
and Technology, Nagpur

Vice Principal
Tulsiramji Gaikwad-Patil
College Of Engineering &
Technology, Nagpur.

Principal
Tulsiramji Gaikwad Patil College Of
Engineering and Technology, Nagpur

Department of Aeronautical Engineering

Scheme of Instructions: Semester–VI (Third Year B.Tech.in Aeronautical Engineering)

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs./Wk	Credits	EXAM SCHEME				
									CT1	CT2	TA/CA	ESE	TOTAL
1	PCC	BAE3601	Propulsion-II	3	-	-	3	3	15	15	10	60	100
2	PCC	BAE3602	Aerodynamics-II	3	-	-	3	3	15	15	10	60	100
3	PCC	BAE3603	Aircraft Design	3	-	-	3	3	15	15	10	60	100
4	PCC	BAE3604	Propulsion-II Lab	-	-	2	2	1	-	-	25	25	50
5	PCC	BAE3605	Aircraft Design-I Lab	-	-	2	2	1	-	-	25	25	50
6	PCC	BAE3606	Computer Aided Engineering Lab	-	-	2	2	1	-	-	25	25	50
7	PROJ	BAE3607	Mini Project	-	-	4	4	1+1*	-	-	50	50	100
8	PEC	BAE3608-11	Program Elective-III	3	-	-	3	3	15	15	10	60	100
9	PEC	BAE3612-15	Program Elective-IV	3	-	-	3	3	15	15	10	60	100
10	OEC	B$$XX01-14	Open Elective-II	3	-	-	3	3	15	15	10	60	100
11	MCC	BAU3606	Social Awareness	2	-	-	2	Audit	-	-	-	-	-
			Total	20	-	10	30	23	90	90	195	485	850

L-Lecture T-Tutorial P-Practical
CT1-ClassTest1 TA/CA-Teacher Assessment/Continuous Assessment
CT2-ClassTest2 ESE-End Semester Examination(For Laboratory End Semester performance)
*Every student will undergo industrial training/internship for two weeks in summer vacation after B.E.VI sem. examination, upon successful completion of industrial training/internship01 credit will be awarded after the submission of report in prescribed format.

Course Category	HSMC (Hum. Soc. Sc Mgmt.)	BSC (Basic Sc.)	ESC (Engg. Sc.)	PCC (Programme Core Courses)	PEC (Programme Elective Courses)	OEC (Open Elective) Courses other discipline)	Project/Seminar &Industrial Training	MCC (Mandatory Courses)
Credits	--	--	--	12	06	03	02	Yes
Cumulative Sum	08	26	21	47	12	06	03	--

Progressive Total Credits =101+23 = 124

Head Of Department
Aeronautical Engineering
Tulsiramji Gaikwad- Patil
College Of Engineering And
Technology, Nagpur

Dean Academics
Tulsiramji Gaikwad-Patil
College Of Engineering
and Technology, Nagpur

Vice Principal
Tulsiramji Gaikwad-Patil
College Of Engineering &
Technology, Nagpur.

Principal
Tulsiramji Gaikwad Patil College Of
Engineering and Technology, Nagpur

List of Electives offered
By
Aeronautical Engineering Department

Program Elective- III	Program Elective- IV
Semester VI	Semester VI
BAE3608: Space Flight Mechanics	BAE3612- Refrigeration & Air-conditioning
BAE3609: UAV & Systems	BAE3613- Introduction to Vibrations
BAE3610: Aircraft Systems & Control	BAE3614- Boundary layer Theory
BAE3611: Aircraft Navigation & Communication System	BAE3615- Renewable Energy Resources

Head Of Department
Aeronautical Engineering
Tulsiramji Gaikwad- Patil
College Of Engineering And
Technology, Nagpur

Dean Academics
Tulsiramji Gaikwad-Patil
College Of Engineering
and Technology, Nagpur

Vice Principal
Tulsiramji Gaikwad-Patil
College Of Engineering &
Technology, Nagpur.

Principal
Tulsiramji Gaikwad Patil College Of
Engineering and Technology, Nagpur

Third Year (Semester-VI) B.E. Aeronautical Engineering

BAE3601: Propulsion-II

Third Year B.Tech (Sixth Semester)

BAE3601: Propulsion-II

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.	Study the types of rockets and their working principles.
2.	Characterize the advancement, performance and parameters of rocket engines.
3.	Study different type of feed systems used in modern chemical rockets.
4.	Explain the basic concepts and working principle of electric and Ion Propulsion.
5.	Understand the configurations of rocket nozzles, associated problems its application.

Course Contents

Unit I	**History and Principles of Rocket Propulsion** The development of the rocket, Classification of rocket engines and their operating principle, Multi-stage rockets, Thermal Rocket engine: Basic configuration, The development of thrust and the effect of the atmosphere, The thermodynamics of the rocket engine, The thermodynamic thrust equation, Specific impulse of rocket engine; Numerical problems.
Unit II	**Rocket Nozzle Theory** Ideal Rocket Nozzle, Assumptions for ideal rocket nozzle, Thermodynamic relations, Isentropic flow through nozzle, under expanded and over expanded nozzles **Nozzle configurations**: Conical, Bell shaped nozzles, Two stepped nozzles, Nozzles with aerodynamic boundaries **Real nozzles**: Principal losses, multiphase flow, performance correction factors and performance parameters.
Unit III	**Solid Propellant Rocket Engines** Basic configuration, The properties and the design of solid motors, Propellant composition: Additives, Toxic exhaust, Thrust stability, Thrust profile and grain shape; Integrity of the combustion chamber: Thermal protection, Inter-section joints, Nozzle thermal protection; Ignition, Thrust vector control.
Unit IV	**Liquid Propellant Rocket Motors** The basic configuration of the liquid propellant engine, The combustion chamber and nozzle: Injection, Ignition, Combustion instability, Thrust vector control; Liquid propellant distribution systems, Cooling of liquid-fuelled rocket engines. **Hybrid rocket motors**: The basic configuration of a hybrid motor, Propellants and ignition, Combustion, Grain cross-section, Propulsive efficiency.
Unit V	**Electric Propulsion:** Principles of electric propulsion: Electric vehicle performance, Vehicle velocity as a function of exhaust velocity, Vehicle velocity and structural/propellant mass. Electric thrusters: Electro-thermal thrusters, Arc-

	jet thrusters, Non-Thermal electric thrusters, Propellant choice, Electrical efficiency; Plasma thrusters, Low-power electric thrusters, Electrical power generation, Applications of electric propulsion. Introduction and fundamentals of Ion propulsion: Performance Analysis, Characteristic Velocity, Payload, Specific Power; Electrical Thrust Devices: Ion and Colloid. Electromagnetic thrusters: Ion propulsion, Electric field and potential, Ion thrust.
Text Books	
1	George P. Sutton, Elements of rocket propulsion, Wiley and Sons, Inc, 7th Edition, 2001.
2	Martin J.L Turner, Rocket and Spacecraft Propulsion: Principles, Practice and New Developments, Springer: Praxis Publishing, 3rd Edition, 2009.
3	K. Ramamurthi, Rocket Propulsion, Trinity Press, 3rd Edition, Reprint, 2016.
Reference Books	
1	Mukunda H. S., Understanding Aerospace chemical propulsion, Interline publications, 2nd Ed. 2004.
2	Philip G. Hill, Carl R. Peterson, Mechanics and Thermodynamics of Propulsion, Pearson, 12th Edition, 2014.
3	Gorden, C.V., Aerothermodynamics of Gas Turbine and Rocket Propulsion, AIAA Education Series, New York, 3rd Edition, 1986.
Useful Links	
1	https://nptel.ac.in/courses/101/106/101106033/
2	https://nptel.ac.in/courses/101/101/101101002/
3	https://nptel.ac.in/courses/101/106/101106082/

BAE3601	**Course Outcomes**
CO1	**Understand** various concepts of advanced propulsion techniques.
CO2	**Identify** and describe various configurations of nozzles, problems associated with real nozzle and need of idealization.
CO3	**Comprehend** the problems on solid, liquid and hybrid rocket motors and their composition.
CO4	**Solve** the problems on thermodynamic thrust equation and specific impulse.
CO5	**Explicate** the fundamentals of rocket propulsion and working of individual rocket propulsion components.

Third Year (Semester-VI) B. Tech Aeronautical Engineering

BAE3602: Aerodynamics-II

Third Year B. Tech (Sixth Semester)

BAE3602: Aerodynamics-II

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 get insight into the basic aspects of compressible flow.
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	**One Dimensional Compressible Flow:** Energy, Momentum, continuity and state equations, velocity of sound, adiabatic steady state flow equations, Isotropic one dimensional flow, Flow through convergent- divergent passage, Performance under various back pressures, Effect of Mach number and compressibility effects, Flow in Constant-Area Ducts with Friction (Fanno Flow) & Constant-Area Ducts with heat (Raleigh Flow)
Unit II	**Concept of Waves in Fluid** Mach waves, Compression waves, Expansion waves. Isentropic flow, Adiabatic flow, Shock waves, Prandtl equation and Rankine –Hugonoit relation, Normal Shock Waves and Equations, Oblique Shocks and Equations, Bow Shocks in 2D. Numericals, shock polar, flow past wedges and concave corners, strong, weak and detached shocks.
Unit III	**Compressible Flow and Shock Interaction** Conical Shocks, Bow Shocks in 3D. Shock interactions, Shock reflection from boundaries, Shockwave Boundary Layer interaction. Prandtl-Meyer expansion fans. Shock Expansion Methods. Mach Number and Area rule, Flow through a Nozzle: Convergent Nozzle, Convergent Divergent Nozzle, Under-expanded and Over-expanded Nozzle flows.
Unit IV	**Differential Equation of motion** Steady compressible flows, Small perturbation potential equations, Solution for subsonic and supersonic flow, Prandtl-Glauert transformation relation for subsonic flows. Linearized and exact 2-D supersonic flows theory and its application for calculation of lift and drag and pitching moments centre of pressure, Prandtl-Glauert correction. Compressibility effects on aerodynamic coefficients.
Unit V	**Principles of model testing** Types of subsonic wind tunnels, Balances and measurements, Interference effects, transonic, Supersonic and hypersonic wind tunnels and characteristic features, their operation and performance, Smock Tunnel, Shock tubes and shock tunnels Free flight testing, Measurements of pressure, velocity, density and Mach number - Flow visualization methods of subsonic and supersonic flows.

Text Books

1	Anderson, J. D., Modern Compressible Flow with Historical Perspective, 3rd Ed, McGraw Hill, 2003.
2	Yahya, S.M., Fundamentals of Compressible Flow, 3rd Ed., New Age International, 2003.
3	L.J. Clancy, "Aerodynamics" Sterling Book House, 3rd Ed, 2006.
Reference Books	
1	Rathakrishnan, E., "Gas Dynamics", 6th Edition, Prentice Hall of India, 2017.
2	Shapiro, A.H., "Dynamics and Thermodynamics of Compressible Fluid Flow", Ronald Press, Volume I, 1982.
3	Zucrow, M.J. and Anderson, J.D., "Elements of gas dynamics", McGraw-Hill Book Co., New York, 3rd Ed , 1989.
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

BAE3602	**Course Outcomes**
CO1	**Solve** the problems on the parameters of compressible flow.
CO2	**Apply** lifting line theory in problem solving.
CO3	**Apply** knowledge of oblique shock and expansion wave formation in solving the problems on fluid flow.
CO4	**Utilize** the concepts of compressible flow and shock phenomenon in understanding flow behavior.
CO5	**Understand** flow visualization technique and model testing and use the knowledge for practical applications.

Third Year (Semester-VI) B. Tech Aeronautical Engineering				
BAE3603: Aircraft Design				
Third Year B. Tech (Sixth Semester)				
BAE3603: Aircraft Design				
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 understand the choice of the selection of design parameters, fixing the geometry.
3.	To investigate the performance and stability characteristics of airplanes.
4.	To the study Wing Design and Airworthiness requirements & V-n diagram, loads

Course Contents	
Unit-I	**Introduction:** State of art in airplane design, Purpose and scope of airplane design, Classification of airplanes based on purpose and configuration. Factors affecting configuration, Merits of different plane layouts. Stages in Airplane design. Designing for manufacturability, Maintenance, Operational costs, Interactive designs.
Unit-II	**Preliminary Design Procedure** Data collection and 3-view drawings, their purpose, weight estimation, Weight equation method, Development and procedures for evaluation of component weights. Weight fractions for various segments of mission. Choice of wind loading and thrust. Loading .
Unit-III	**Power Plant Selection** Choices available, comparative merits, Location of power plants, Functions dictating the locations.
Unit-IV	**Design of Wing, Fuselage and Empennage** Selection of aerofoil. Selection of Wing parameters, selection of sweep, Effect of Aspect ratio, Wing Design and Airworthiness requirements, V-n diagram, loads, Structural features. Elements of fuselage design, Loads on fuselage, Fuselage Design. Fuselage and tail sizing. Evaluate of tail surface areas, Tail design, Structural features, Check for nose wheel lift off.
Unit-V	**Design of Landing Gear and Control Surface:** Landing Gear Design, Loads on landing gear, Preliminary landing gear design. Elements of Computer Aided and Design, Special consideration in configuration lay-out, Performance estimation. Stability aspects on the design of control surface.

Text Books	
1	Raymer, D.P. Aircraft conceptual Design, AIAA series, 5th edition, 2012.
2	Torenbeck, E. Synthesis of Subsonic Airplane Design, Delft University Press, U.K. 1986.
3	Kuechemann, D, The Aerodynamic Design of Aircraft, American Institute of Aeronautics publishers, 2012
Reference Books	
1	Jan Roskam, Airplane Design, Vol-I to VII, Dar Corporation, 1997.
2	John P. Fielding, Introduction to Aircraft Design, AIAA, 2nd Edition, 2012.
3	Thomas C. Corke, Design of Aircraft, Prentice Hall, 2003.

	Useful Links
1	https://onlinecourses.nptel.ac.in/noc21_ae04/preview
2	https://archive.nptel.ac.in/courses/101/101/101101083/

BAE3603	**Course Outcomes**
CO1	**Investigate** the preliminary design of an aircraft starting from data collection to satisfy mission specifications
CO2	**Perform** the weight estimation and power plant selection for a specific aircraft
CO3	**Estimate** the geometric and design parameters of an airplane
CO4	**Design** a system, component or process to meet requirements for aircraft systems
CO5	**Demonstrate** complete design of an aircraft to a level of sufficient detail to satisfy given mission specifications

Third Year (Semester-VI) B.E. Aeronautical Engineering					
BAE3604:Propulsion- II Lab					
Third Year (Semester-VI)					
BAE3604:Propulsion- II Lab					
Teaching Scheme			**Examination Scheme**		
Practical	**2 Hrs/week**		**CA**	**25 Marks**	
Total Credit	**1**		**ESE**	**25 Marks**	
			Total	**50 Marks**	
			Duration of ESE: 02 Hrs 00 Min.		
Course Objectives					
The Objectives of this course is:					
1	Study the performance of premixed flames and jet engine combustion chamber				
2	Known the performance of a aviation fuel/ propellant				
3	Study the performance of hybrid rocket propellant				
4	Study the performance of propeller at different speeds				
Sr. No.	**List of Experiment**	**CO**			
1	Measurement of burning velocity of a premixed flame	**1**			
2	Establishing flame stability of pre-mixed flame through flame stability setup.	**1**			
3	Combustion performance studies in a jet engine combustion chamber	**1**			
4	Compute burning rate of the propellant	**2**			
5	Estimate the calorific value of solid rocket propellant	**2**			
6	Determination of heat of combustion of aviation fuel	**2**			
7	Performance study of hybrid motor using a thrust stand	**3**			
8	Analysis of grain stress and strain of a solid propellant	**3**			
9	Estimate the performance of a propeller at different speeds	**4**			
10	Measurement of ignition delay of a single propellant with different shapes	**5**			
Text Books					
1	K. Ramamurthi, Rocket Propulsion, Trinity Press, 3rd Edition, Reprint, 2016.				
2.	Philip G. Hill, Carl R. Peterson, Mechanics and Thermodynamics of Propulsion, Pearson, 12th Edition, 2014.				

BAE3604	Course Outcomes
CO1	**Estimate** the performance of premixed flames and jet engine combustion chamber
CO2	**Evaluate** the performance of a aviation fuel/ propellant
CO3	**Determine** the performance of hybrid rocket propellant
CO4	**Estimate** the performance of propeller at different speeds
CO5	**Evaluate** the performance of premixed flames and jet engine combustion chamber

Third Year (Semester-VI) B.E. Aeronautical Engineering			
BAE3605: Aircraft Design-I Lab			
Third Year (Semester-VI)			
BAE3605: Aircraft Design-I Lab			
Teaching Scheme		**Examination Scheme**	
Practical	**2 Hrs/week**	**CA**	**25 Marks**
Total Credit	**1**	**ESE**	**25 Marks**
		Total	**50 Marks**
		Duration of ESE: 02 Hrs 00 Min.	

Course Objectives

The Objectives of this course is:

1	Understand the need of data collection on different aircrafts for design.
2	Known the different Structural configurations of fuselage and wings on 3-D Design Software.
3	Understand the simulation3-D Components subjected to various structural loadings.
4	Study the weight and load of an aircraft components such as wings and fuselage.
5	Understand the drag, Guest Load V-n diagram designed over the airplane

Sr. No.	List of Experiment	CO
1	Comparative configuration study of different types of airplanes	**CO**
2	Comparative study on specification and performance details of different types of airplanes	**1, 4**
3	Preparation of comparative data sheets	**2, 5**
4	Worksheet layout procedures	**2, 5**
5	Comparative graphs preparation and selection of main parameters for the aircraft design	**2, 5**
6	Preliminary weight estimations and selection of main parameters	**1, 4**
7	Powerplant selection, Airfoil selection, Wing tail and control surfaces selection	**1, 4**
8	Preparation of layouts of balance diagram and three view drawings	**1, 4**
9	Estimation of various drags	**1, 4**
10	Detailed performance calculations and stability estimates	**1**

Text Books

1	Raymer, D.P. Aircraft conceptual Design, AIAA series, 5th edition, 2012.
2	Torenbeck, E. Synthesis of Subsonic Airplane Design, Delft University Press, U.K. 1986.
3	Kuechemann, D, The Aerodynamic Design of Aircraft, American Institute of Aeronautics publishers, 2012

Useful Links

1	https://onlinecourses.nptel.ac.in/noc21_ae04/preview
2	https://archive.nptel.ac.in/courses/101/101/101101083/

BAE3605	Course Outcomes
CO1	**Investigate** the preliminary design of an aircraft starting from data collection to satisfy mission specification
CO2	**Perform** the weight estimation and power plant selection for a specific aircraft
CO3	**Estimate** the geometric and design parameters of an aircraft
CO4	**Estimate** various drags of an aircraft as per the specific aircraft geometric parameters
CO5	**Demonstrate** complete design of an aircraft to a level of sufficient detail to satisfy given mission specification

Fourth Year (Semester-VII) B.E. Aeronautical Engineering

BAE3606: Computer Aided Engineering Lab

Third Year (Semester-VI)

BAE3606: Computer Aided Engineering Lab

Teaching Scheme		Examination Scheme	
Practical	2 Hrs/week	**CA**	25 Marks
Total Credit	1	**ESE**	25 Marks
Duration of ESE: 02 Hrs 00 Min.		**Total**	50 Marks

Course Objectives

The Objectives of this course is:

1	Basic Study the functions of ANSYS and working on ANSYS
2	Known of the one dimensional structural Load on beams
3	Study the axi-symmetry structure structural 1D and 2D problems.
4	Evaluate steady state thermal & transient thermal analysis problems

Sr. No.	List of Experiment	CO
1.	Introduction to ANSYS	**1**
2.	Cantilever beam with point load at free end	**1**
3.	Distributed loading of a 1d cantilever beam	**2**
4.	Application of distributed loads	**2**
5.	Buckling failure	**3**
6.	Stress analysis of axi-symmetry structure	**3**
7.	Analysis of 2d truss	**4**
8.	Thermal analysis	**3**
9.	Modal analysis of a cantilever beam	**3**
10.	Modal analysis of stepped shaft	**3**
11.	Harmonic analysis of guitar	**4**
12.	Radiation exchange between surfaces	**5**

Text Books

1	Practical Finite Element Analysis, Nitin S. Gokhale, Finite To Infinite, 2020.
2.	Finite Element Analysis Theory And Application With ANSYS, Moaveni, Pearson Education, 2011.

Reference Books

1.	John P. Fielding, Introduction to Aircraft Design, AIAA, 2nd Edition, 2012.
2.	Thomas C. Corke, Design of Aircraft, Prentice Hall, 2003

BAE3606	Course Outcomes
CO1	**Understand** the functions of ANSYS and working on ANSYS
CO2	**Formulate** and solve one dimensional structural Load on beams
CO3	**Solve** axi-symmetry structure structural 1D and 2D problems.
CO4	**Evaluate** steady state thermal & transient thermal analysis problems
CO5	**Solve** analysis Radiation exchange between surfaces problems

Third Year (Semester-VI) B.E. Aeronautical Engineering

BAE3607:Mini Project

Third Year (Semester-VI)

BAE3606: Mini Project

Teaching Scheme		Examination Scheme	
Practical	2 Hrs/week	**CA**	25 Marks
Total Credit	1	**ESE**	25 Marks
		Total	50 Marks
		Duration of ESE: 02 Hrs 00 Min.	

Course Objectives

The Objectives of this course is:

1	Study the experimentation and/or computational work ethically.
2	Study Complete the works within the deadline.
3	Known as Prepare neat and neat project report without any errors.
	Learn about Communicating effectively in English during project demonstration, orals and viva-voce.
5	Make understand to perform the experimentation and/or computational work ethically.

Instructions:

- The objective of the project work is to enable the students in convenient groups of not more than 4 members on a project involving theoretical and experimental studies related to the branch of study.
- Every project work shall have a guide who is the member of the faculty of the institution.
- Six periods per week shall be allotted in time table and this time shall be utilized by the students to receive the directions from the guide, on library reading, laboratory work, computer analysis or field work as assigned by the guide and also to present in periodical seminars on progress made in the project.
- Each student shall finally produce a comprehensive report covering back ground information, literature survey, problem statement, project work details and conclusion.
- This final report shall be typewritten form as specified in the guidelines.
- The continuous assessment shall be made as prescribed by the regulation TGPECT, Nagpur.

BAE3607	Course Outcomes
CO1	**Understand** Do the experimentation and/or computational work ethically.
CO2	**Evaluate** Complete the project works within the deadline.
CO3	**Prepare** neat and neat project report without any errors.
CO4	**Understand** Communicate effectively in English during project demonstration, orals and viva-voce.
CO5	**Estimate** the experimentation and/or computational work ethically.

Department Elective-III

Third Year (Semester-VI) B. Tech Aeronautical Engineering

BAE3608: Space Flight Mechanics

Third Year B. Tech (Sixth Semester)

BAE3608: Space Flight Mechanics

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 solar trajectory system.
2.	To make the student understand the N-body problem and the concepts of orbital mechanics.
3.	To investigate the performance and stability characteristics of interplanetary trajectories

Course Contents

Unit-I	**Basic Concepts** The solar system, Reference frames and coordinate systems, The celestial sphere, The ecliptic, Motion of vernal equinox, Sidereal time, Solar time, Standard time, The earth's atmosphere.
Unit-II	**The General N-Body Problem** The Many body problems, Lagrange - Jacobi identity, The circular restricted three body problem, Libration points, Relative Motion in the N-body problem, The two - body problem, Satellite orbits, Relations between position and time, Orbital elements.
Unit-III	**Satellite Injection and Satellite Orbit Perturbations** General aspects of satellite injections, Satellite orbit transfer, Various cases, Orbit deviations due to injection errors, Special and general perturbations, Cowell's Method, Encke's method, Method of variations of orbital elements, General perturbations approach.
Unit-IV	**Interplanetary Trajectories** Two dimensional interplanetary trajectories, Fast interplanetary trajectories, Three dimensional interplanetary trajectories, Launch of interplanetary spacecraft, Trajectory about the target plant.
Unit-V	**Ballistic Missile Trajectories** The boost phase, The ballistic phase, Trajectory geometry, Optimal flights, Time of flight, Re-entry phase, The position of the impact point, Influence coefficients. **Materials For Spacecraft** Space environment, Peculiarities, Effect of space environment on the selection of materials of spacecraft.

Text Books

1	Sutton, G.P & Oscar Bilbraz, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 7th Edition, 2004.
2	Van de Kamp, P., "Elements of Astro-mechanic", Pitman, 2nd Ed., 1979.
3	Cornelisse, J.W., "Rocket propulsion and space dynamics", W.H. Freeman & Co., 4th Ed., 1984.
Reference Books	
1	Parker, E.R., "Materials for Missiles and Spacecraft", McGraw Hill Book Co., Inc., 3rd Ed., 1982.
2	Thompson, W.T., "Introduction to Space Dynamics", Dover, New York, 1st Ed., 1986.
Useful Links	
1	https://nptel.ac.in/courses/101/105/101105030/
2	https://nptel.ac.in/courses/101/105/101105083/
3	https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ae06/

BAE3608	**Course Outcomes**
CO1	**Explicate** the concepts of solar trajectory system and the earth's atmosphere.
CO2	**Portray** the motions of N-body problem and the concepts of orbital mechanics
CO3	**Explain** the launching of satellites and its injection characteristics
CO4	**Depict** the various satellite perturbation methods
CO5	**Estimate** the various types of interplanetary trajectories

Department Elective-III

Third Year (Semester-VI) B. Tech. Aeronautical Engineering

BAE3609: UAV and Systems

Third Year B. Tech (Sixth Semester)

BAE3609: UAV and Systems

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 importance of UAVs with respect to their applications.
2.	To make the student understand the subsystems and configurations of UAV.
3.	To gate the performance with design standards and regulatory aspects of UAVs.

Course Contents

Unit-I	**Introduction to UAV** History of UAV, classification, Introduction to Unmanned Aircraft Systems, models and prototypes, System Composition, applications.
Unit-II	**The Design of UAV System** 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** Autopilot, AGL, pressure sensors, servos, accelerometer, gyros, actuators, power supply, processor, integration, installation, configuration, and testing.
Unit-IV	**Communication Payloads and Controls** Payloads, Telemetry, tracking, Aerial photography, controls, PID feedback, Radio control frequency range, modems, memory system, simulation, ground test, analysis, trouble shooting.
Unit-V	**Development of UAV Systems** Waypoints navigation, ground control software, System Ground Testing, System In-flight Testing, Future Prospects and Challenges, Case Studies – Mini and Micro UAVs.

Text Books

1	Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2nd Ed., 2007.
2	Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 4th Ed., 1998.
3	Reg Austin "Unmanned aircraft systems: UAV design, development and deployment", Wiley, 5th Ed., 2010.

Reference Books

1	Parker, E.R., "Materials for Missiles and Spacecraft", McGraw Hill Book Co., Inc., 3rd Ed., 1982.

2	Armand J. Chaput, "Design of Unmanned Air Vehicle Systems", Lockheed Martin Aeronautics Company, 1st Ed., 2001.
Useful Links	
1	https://nptel.ac.in/courses/101/104/101104071/
2	https://onlinecourses.nptel.ac.in/noc20_ae03/preview
3	https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ae06/

BAE3609	**Course Outcomes**
CO1	**Understand** knowledge on the importance of UAVs with respect to their applications.
CO2	**Distinguish** between various subsystems and configurations of UAV.
CO3	**Perform** ground test and troubleshooting with respect to UAV operation.
CO4	**Distinguish** between needs of mini and micro UAVs.
CO5	**Gain** insights with design standards and regulatory aspects of UAVs.

Department Elective-III

Third Year (Semester-VI) B. Tech. Aeronautical Engineering

BAE3610:Vibration and Aero- Elasticity

Third Year B. Tech (Sixth Semester)

BAE3610: Vibration and Aero- Elasticity

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 unforced and force response system vibration.
2.	To make the student understand the concept of dynamics of multi Degree of freedom system..
3.	To get the knowledge of principles of aero-elasticity..

Course Contents

Unit-I	**Introduction** Overview of the course, practical applications and research trends, harmonic and periodic motions, vibration terminology, introduction to spring and mass system, representation of practical problems in spring and mass system, vibration model, equation of motion.
Unit-II	**Single-DOF Free Vibrations** Natural frequency energy method, Rayleigh method, Principle of virtual work, Damping models. Viscously damped free vibration, Special cases: oscillatory, non-oscillatory and critically damped motions. Logarithmic decrement, Experimental determination of damping coefficient, Forced harmonic vibration, Magnification factor. Rotor unbalance, Transmissibility, Vibration Isolation Equivalent viscous damping, Sharpness of resonance.
Unit-III	**Two-DOF Free Vibrations** Generalized and Principal coordinates, derivation of equations of motion Lagrange's equation, Coordinate coupling, Forced Harmonic vibration, Tuned absorber, determination of mass ratio. Tuned and damped absorber, unturned viscous damped Forced Harmonic vibration.
Unit-IV	**Vibration Absorber** Tuned absorber, determination of mass ratio. Tuned and damped absorber, unturned viscous damper. **Multi-DOF Vibration** Derivation of equations of motion, influence coefficient method, Properties of vibrating systems: flexibility and stiffness matrices, reciprocity theorem, Modal analysis: undamped, Modal analysis: damped.
Unit-V	**Introduction Aero elastic Problems** Deformation of Structures and Influence Coefficients. Energy Method. Classification and Solution of Aero elastic Problems, Static Aero elasticity. Divergence of 2-D airfoil and Straight Wing. Aileron Reversal. Control Effectiveness. Wing loading and deformations. Swept Wing. Dynamic Aero elasticity. Dynamic/Flutter model of 2-D Airfoil. Finite State Model. Flutter Calculation. U-g Method. P-k Method. Exact Treatment of Bending - Torsion Flutter of Uniform Wing.

Text Books

1	P. Srinivasan, Mechanical Vibration Analysis, Tata Mc Graw Hill, New Delhi, 4th edition, 1985.

2	J. P. Den Hartog, Mechanical Vibration, Mc Graw Hill, New York, 4th edition, 2005.
3	E.H. Dowell, A Modern Course in Aero elasticity, Springer-Verlag, 5th edition, 2012.
Reference Books	
1	N. L. Meirovitch, Elements of vibration Analysis, Mc Graw Hill, New York, 1st edition, 1986.
2	R. L. Bisplingh off, H. Ashley and R. L. Halfman, Aero elasticity, Addison- Wesley, 1st edition, 1955.
Useful Links	
1	https://nptel.ac.in/content/syllabus_pdf/101104005.pdf
2	https://nptel.ac.in/courses/112/103/112103111/
3	https://nptel.ac.in/courses/112/103/112103112/

BAE3610	**Course Outcomes**
CO1	**Estimate** unforced and force response for damped and undammed system.
CO2	**Differentiate** Dynamic, static and impulse loading and **estimate** damping ratio.
CO3	**Analyze** dynamics of multi Degree of freedom and rotating system.
CO4	**Understand the** Synthesis the dynamics of aircraft structures.
CO5	**Explicate** principles of aero-elasticity with Classification and Solution of Aero elastic Problems.

Department Elective-III				
Third Year (Semester-VI) B. Tech. Aeronautical Engineering				
BAE3611: Aircraft Navigation & Communication System				
Third Year B. Tech (Sixth Semester)				
BAE3611: Aircraft Navigation & Communication System				
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 flight control systems and operation of flight control system.
2.	To make the student understand the concept of Navigation & communication system
3.	To get the knowledge to Flight data recorder & Cockpit voice recorder system

Course Contents

Unit-I	**Introduction to Communication System:** Radio communication system fundamentals, EM waves, medium of propagation, Radio frequency spectrum, uses and limitation of R.F. bands. Radio wave propagation, ground wave, sky wave, radiation angle, skip distance, diffraction, field strength, absorption, Scattering, reflection, fading, ducting, critical frequency, Antenna Fundamentals. Dipole, half wave dipole, resonant and Non-resonant antenna. Antenna gain, directional power, Antenna Loses and efficiency, band width, beam width, band width, polarization Grounding of antenna, loading of antenna, requirements of the avionic systems for various channels in radio communication, surface taxing, air to ground/ATC, air to air, emergency radio communication, distress channel etc, purpose and usage, physical qualities required. ACARS communication systems.
Unit-II	**Types of Communication Systems:** Very High Frequency (VHF), High Frequency (HF), Ultra High Frequency (UHF), Satellite communication (SATCOM), Intercom for pilots and the crew, Public address System (PA system) for air crew to passengers are explained to the students VHF, HF, UHF Systems used, their merits, demerits.
Unit-III	**Navigation System:** Basic block level explanation for working of VHF, HF, UHF communication systems used in air craft, their frequency bands, limitations. Aircraft PA systems, intercom and Passenger entertainment systems: Brief explanations of block level PA system, intercom and passenger entertainment system.
Unit-IV	**FDR, CVR and GNSS Systems:** FDR: Brief explanation of block diagram level working of FDR and its special construction. List of important flight parameters which are recorded in FDR, Purpose and use of FDR in training, planning of spares, accident investigation, Validity of warranty etc. Location of FDR and reason for it is explained CVR: Brief explanation of working of a CVR Purpose and use of CVR in accident investigation, air crew coordination training, location of CVR. GPS, DGPS, LAAS and WAAS

	systems.
Unit-V	**Introduction to RADAR Systems** Explanation of basic working principles of RADAR with block diagram. Radar range equation-statement of equation and explanation of the terms involved in Radar range equation Purpose and use RADAR in various fields. Basic explanation of meaning of Primary RADAR, Third array RADAR, advantages, and disadvantages Working of various types of RADARS: Third array Surveillance, Doppler, INS, GPS: Brief explanation of block diagram level working of Third array surveillance RADAR, Purpose and areas of use. Brief explanation of block diagram level working of Doppler navigational RADAR, Purpose and areas of use. Brief explanation of block diagram level working of Inertial Navigation System (INS) Purpose and application areas for INS. Brief explanation of working principles of satellite navigation system using GPS, Advantages, disadvantages of GPS.
Text Books	
1	Radio Communication by D. C. Green, Longman, 2nd edition, 2000.
2	Introduction to Radar systems by M. Skollnik, Mc Graw Hill, India, 3rd edition, 2017.
3	Principles of Avionics Albert Helfrick, Airline Avionics Publisher, 3rd edition, 2004.
Reference Books	
1	William H. Heiser and David T. Pratt, Hypersonic Air Breathing propulsion, AIAA Education Series, 3rd edition, 1994.
2	John T. Bertin, Hypersonic Aerothermodynamics, AIAA Inc., Washington D, 4th edition, 1994.
Useful Links	
1	https://nptel.ac.in/courses/108/104/108104091/
2	https://nptel.ac.in/courses/101/108/101108056/
3	https://nptel.ac.in/courses/108/104/10810471/

BAE3611	**Course Outcomes**
CO1	**Describe** fundamentals of electronic communication systems and their application in aviation
CO2	**Examine** Different types of Navigation & communication system
CO3	**Scrutinize** different types of Flight data recorder & Cockpit voice recorder system
CO4	**Perform** qualitative analysis on simple electronic communication system
CO5	**Study** the RADAR & INS System and its application to an aircrafts.

Department Elective-IV				
Third Year (Semester-VI) B. Tech. Aeronautical Engineering				
BAE3612: Refrigeration and air- Conditioning				
Third Year B. Tech (Sixth Semester)				
BAE3612: Refrigeration and air- Conditioning				
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 basics concepts of Refrigeration & Air-Conditioning.
2.	To make the student understand the working of components in Refrigeration & Air-Conditioning systems.
3.	To get the knowledge of the different processes involved in RAC and other performance parameters for different systems of RAC.

Course Contents

Unit-I	**Introduction,** Concept and Development of Vapor Compression Refrigeration Cycle from Reverse Carnot Cycle, Effects of Super-heating and Sub-cooling, with analytical treatment. Refrigerant: Environmental Impact- Montreal, Kyoto protocols-Eco Friendly Refrigerants, alternatives to HCFCs, Secondary Refrigerants. Components of Refrigeration: Compressor Types, performance, Characteristics, Types of Evaporators & Condensers and their functional aspects, Expansion Devices and their Behavior with fluctuating land, cycling controls.
Unit-II	**Vapor Absorption Systems**-Aqua Ammonia & Li-Br Systems, Steam Jet Refrigeration, Thermo-Electric Refrigeration, Vortex Tube.Compound Refrigeration System, Multiple Compressor System, Multiple Evaporator System with analytical treatment Air cycle refrigeration and its applications.
Unit-III	**Psychometric** :Introduction to psychometric properties and processes of air, Classification of air conditioning systems, Applications of Psychometric to various air conditioning system Thermal comfort, Heat exchanger between man and environment, Cooling and Heating load calculations.
Unit-IV	**Air Conditioning Systems:** Introduction, Factors Affecting Comfort Air Conditioning, Air Conditioning System, Equipments Used in an Air Conditioning System, Classification of Air Conditioning Systems, Comfort Air Conditioning System, Industrial Air Conditioning System, Winter Air Conditioning System, Summer Air Conditioning System, Year-Round Air Conditioning System.
Unit-V	Room air distribution, Selection of supply and return grills and diffusers, types of air filter,

	static and dynamic losses in Ducts, Duct design methods, Duct friction chart, clean rooms. Types of fans, their characteristics and application. Types of AC systems Unitary, Central air system, , air- water system. VRF system, Chilled ceilings and chilled beams, displacement ventilation, two stage Evaporative cooling
Text Books	
1	Refrigeration and Air conditioning by C.P Arora, McGraw-Hill
2	Refrigeration and Air conditioning, by Manohar Prasad, New Age International (P) Ltd. Pub.
3	Refrigeration and Air conditioning by R.C. Arora, PHI
Reference Books	
1.	Principles of Refrigeration by Roy J. Dossat. Pearson Education
2.	Refrigeration and Air conditioning by Stoecker & Jones. McGraw-Hill
3.	Refrigeration and Air conditioning by Arora & Domkund war. Dhanpat Rai
Useful Links	
1	https://nptel.ac.in/courses/101/103/101103003/
2	https://nptel.ac.in/courses/101/105/101105024/
3	https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ae06/

BAE3612	**Course Outcomes**
CO1	**Understand** the basics concepts of Refrigeration & Air-Conditioning and its future prospects.
CO2	**Explain** the construction and working of various components in Refrigeration &Air-Conditioning systems.
CO3	**Understand** the different types of RAC systems with their respective applications.
CO4	**Analysis** of different processes involved in RAC and other performance parameters for different systems of RAC.
CO5	**Study** the RADAR & INS System and its application to an aircrafts.

Department Elective-IV

Third Year (Semester-VI) B. Tech. Aeronautical Engineering

BAE3613: Introduction to Vibrations

Third Year B. Tech (Sixth Semester)

BAE313: Introduction to Vibrations

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 basics concepts of vibrations and its effect on the structural integrity.
2.	To make the student understand the concept the frequency and mode shapes degree of freedom systems.
3.	To get the knowledge of the concept of the continuous and discrete vibration systems.

Course Contents

Unit-I	**Introduction** Classification of Vibration Systems, Harmonic motion, Vector representation of harmonic motion, Natural frequency & response, Effects of vibration, superposition of simple harmonic motions ,beats, Fourier analysis analytical and numerical methods, Single Degree Freedom System, Equation of motion, Newton's method, D Alembert's principle Energy method etc, Free vibration, Natural frequency, Equivalent systems, Displacement, Velocity and acceleration, Response to an initial disturbance
Unit-II	**Single Degree Freedom** Forced Vibration Forced vibration, Harmonic excitation with viscous damping, steady state vibrations, Forced vibrations with rotating and reciprocating unbalance, Support excitation, Vibration isolation, Transmissibility, Vibration measuring instruments, Displacement, velocity and acceleration measuring instruments.
Unit-III	**Two Degree Freedom** Introduction, Principal modes,Double pendulum,Torsional system with damping,Coupled system, Principle of vibration absorber, Un-damped dynamic vibration absorbers, Torsional vibration absorber, Centrifugal pendulum absorbers, Vibration isolators and Dampers. Critical speed of shafts
Unit-IV	**Longitudinal & Transverse Vibrations.** Longitudinal & Torsional vibrations, Damped vibrations, Vibrations of systems with viscous damping, Logarithmic decrement, Energy dissipation in viscous damping, Whirling of uniform shaft, Shaft with one disc with and without damping, Multi disc shafts, Secondary critical speed.

Unit-V	**Multi degree Freedom system** Exact Analysis, Undammed free and forced vibrations of multi degree freedom systems, influence coefficients, Reciprocal theorem, Torsional vibration of multi degree rotor system, Vibration of gear system, Principal coordinates, Continuous systems Longitudinal vibrations of bars, Torsional vibrations of circular shafts**.** Multi Degree Freedom system: Numerical Analysis by Rayleigh's method, Dunkerely's, Holzer's and Stodola methods, Rayleigh Ritz method
Text Books	
1	Mechanical Vibrations G.K. Groover, Jain Brothers, Roorkee.
2	J. P. Den Hartog, Mechanical Vibration, Mc Graw Hill, New York, 4th edition, 2005.
3	Mechanical Vibrations Theory & Applications, Singhal, Katson Books.
Reference Books	
1.	N. L. Meirovitch, Elements of vibration Analysis, Mc Graw Hill, New York, 1st edition, 1986.
2.	R. L. Bisplinghoff, H. Ashley and R. L. Halfman, Aero elasticity, Addison- Wesley, 1st edition, 1955.
Useful Links	
1	https://nptel.ac.in/courses/101/103/101103003/
2	https://nptel.ac.in/courses/101/105/101105024/
3	https://nptel.ac.in/courses/101/103/101103009/

BAE3613	**Course Outcomes**
CO1	**Understand** the different types of vibrations and its effect on the structural integrity.
CO2	**Apply** the concept the frequency and mode shapes corresponding to single and multi degree of freedom systems.
CO3	**Apply** the concept of Single degree free and force vibration and the Methods to minimize the effects of vibration.
CO4	**Known** the concept of the continuous and discrete vibration systems and Analyze the Problems related to continuous vibration of beams and shafts.
CO5	**Apply** the concept to design mechanical components with due Consideration of the effect of vibration.

Department Elective-IV

Third Year (Semester-VI) B. Tech. Aeronautical Engineering

BAE3614: Boundary layer Theory

Third Year B. Tech (Sixth Semester)

BAE3614: Boundary layer Theory

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 basics concepts of of renewable energy resources.
2.	To make the student understand the concept of ocean thermal energy conversion and hydrogen energy.
3.	To get the knowledge of the applications like-heating, cooling, desalination, power generation.

Course Outcomes

Course Contents

Unit-I	**Introduction**: Introduction to energy Sources, Energy demand growth and supply, World Energy futures, Energy sources and their availability, Renewable energy sources, Prospects of renewable energy sources.
Unit-II	**Solar Radiation:** Introduction ,Solar radiation at the earth surface, Flat plate collector, Applications of solar energy: Solar water heating, thermal and Photovoltaic system for electric power generation, Solar distillation, Solar cooker, Disadvantages and applications of solar photovoltaic system
Unit-III	**Wind Energy**: Introduction, Basic Principles of wind energy conversion, Site selection Considerations, Basic Components of a WECS, Classification of WECS systems, Types of wind Machines, Energy storage ,applications of wind energy, environmental aspects. **Tidal Energy**: Introduction, Basic Principle of Tidal Power, Components of Tidal Power Plants, Operation Methods of Utilization of Tidal Energy: Single and Double cycle system, Site Requirements, Storage, Advantages and Disadvantages of Tidal power generation.
Unit-IV	**Geothermal Energy:** Introduction, Estimate of Geothermal Power, Nature of Geothermal Fields, Hydrothermal Resources: Vapour Dominated Systems and Liquid Dominated System, Magma Resources, advantages and Disadvantages of Geothermal energy over other energy forms, applications of Geothermal . **Ocean Energy:** Introduction, Ocean Thermal Electric Conversion (OTCE): Open and Closed cycle OTCE System, Site-Selection, Energy Utilization.
Unit-V	**Biomass Energy**: Introduction, Biomass conversion Technologies: Wet and Dry Processes, Photosynthesis, **Biogas Generation** ,Factor affecting Biodigestion or generation of gas, Classification of Biogas Plants,Types of Biogas,Materials used for Biogas Generation, Selection of site for a

	biogas plants,Utilization of Biogas plants,Thermal Gasification.
Text Books	
1	Nonconventional Energy sources, G D Rai, Khanna Publication, Fourth Edition,
2	Energy Technology, S.Rao and Dr. B.B. Parulekar, Khanna Publication. Solar energy, Subhas P Sukhatme, Tata Mc Graw Hill, 2ndEdition,1996.
3	Fluid mechanics by R. K. Bansal, Laxmi Publications, 9th Ed., 2007.
Reference Books	
1.	Principles of Energy conversion, A. W. Culp Jr.,, McGraw Hill, 1996.
2.	Non-Convention Energy Resources, Shobh Nath Singh, Pearson, 2018.
Useful Links	
1	https://nptel.ac.in/content/storage2/courses/112104118/ui/Course_home-9.htm
2	https://nptel.ac.in/courses/112/106/112106190/
3	https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-072/

BAE3614	**Course Outcomes**
CO1	**Understand** the Viscous flow & Derive the fundamental equations of viscous fluid flow
CO2	**Find** the solution of viscous flow equations and thermal boundary layer
CO3	**Develop** the laminar boundary layer equations & analysis of boundary layer theory
CO4	**Develop** the turbulent boundary layer equations and evaluate the boundary layer thickness
CO5	**Understand** the compressible flow and Solve the compressible boundary layer problem.

Department Elective-IV				
Third Year (Semester-VI) B. Tech. Aeronautical Engineering				
BAE3615: Renewable Energy Resources				
Third Year B. Tech (Sixth Semester)				
BAE3615: Renewable Energy Resources				
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 basics concepts of of renewable energy resources.
2.	To make the student understand the concept of ocean thermal energy conversion and hydrogen energy.
3.	To get the knowledge of the applications like-heating, cooling, desalination, power generation.
4.	
Course Outcomes	

Course Contents	
Unit-I	**Introduction**: Introduction to energy Sources, Energy demand growth and supply, World Energy futures, Energy sources and their availability, Renewable energy sources, Prospects of renewable energy sources.
Unit-II	**Solar Radiation:** Introduction ,Solar radiation at the earth surface, Flat plate collector, Applications of solar energy: Solar water heating, thermal and Photovoltaic system for electric power generation, Solar distillation, Solar cooker, Disadvantages and applications of solar photovoltaic system
Unit-III	**Wind Energy**: Introduction, Basic Principles of wind energy conversion, Site selection Considerations, Basic Components of a WECS, Classification of WECS systems, Types of wind Machines, Energy storage ,applications of wind energy, environmental aspects. **Tidal Energy**: Introduction, Basic Principle of Tidal Power, Components of Tidal Power Plants, Operation Methods of Utilization of Tidal Energy: Single and Double cycle system, Site Requirements, Storage, Advantages and Disadvantages of Tidal power generation.
Unit-IV	**Geothermal Energy:** Introduction, Estimate of Geothermal Power, Nature of Geothermal Fields, Hydrothermal Resources: Vapour Dominated Systems and Liquid Dominated System, Magma Resources, advantages and Disadvantages of Geothermal energy over other energy forms, applications of Geothermal . **Ocean Energy:** Introduction, Ocean Thermal Electric Conversion (OTCE): Open and Closed cycle OTCE System, Site-Selection,Energy Utilization.
Unit-V	**Biomass Energy**: Introduction, Biomass conversion Technologies: Wet and Dry Processes, Photosynthesis,

	Biogas Generation ,Factor affecting Biodigestion or generation of gas, Classification of Biogas Plants,Types of Biogas, Materials used for Biogas Generation, Selection of site for a biogas plants,Utilization of Biogas plants,Thermal Gasification.
Text Books	
1	Nonconventional Energy sources, G D Rai, Khanna Publication, Fourth Edition,
2	Energy Technology, S.Rao and Dr. B.B. Parulekar, Khanna Publication. Solarenergy, Subhas P Sukhatme, Tata Mc Graw Hill, 2ndEdition,1996.
3	Fluid mechanics by R. K. Bansal, Laxmi Publications, 9th Ed., 2007.
Reference Books	
1.	Principles of Energy conversion, A. W. Culp Jr., McGraw Hill, 1996.
2.	Non-Convention Energy Resources, Shobh Nath Singh, Pearson, 2018.
Useful Links	
1	https://nptel.ac.in/content/storage2/courses/112104118/ui/Course_home-9.htm
2	https://nptel.ac.in/courses/112/106/112106190/
3	https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-072/

BAE3615	**Course Outcomes**
CO1	**Describe** the environmental aspects of renewable energy resources. various Conventional energy systems, their prospects and limitations.
CO2	**Describe** the use of solar energy and the various components used in the energy production with respect to applications.
CO3	**Understand** the conversion principles of wind energy and tidal energy
CO4	**Understand** the concept of biomass energy resources and green energy.
CO5	**Acquire** the basic knowledge of ocean thermal energy conversion and hydrogen energy.

Head Of Department
Aeronautical Engineering
Tulsiramji Gaikwad- Patil
College Of Engineering And
Technology, Nagpur

Dean Academics
Tulsiramji Gaikwad-Patil
College Of Engineering
and Technology, Nagpur

Vice Principal
Tulsiramji Gaikwad-Patil
College Of Engineering &
Technology, Nagpur.

Principal
Tulsiramji Gaikwad Patil College Of
Engineering and Technology, Nagpur