INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

AERODYNAMICS OF TURBO MACHINERY								
II Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAEE21	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

This course provides an introduction to the working principles, performance and design of turbo machinery. The course first covers a review of essential fluid and thermo-dynamics. Concepts relevant to all turbo machines are then introduced. Axial turbines and compressors are studied in depth, including their kinematics, performance and design. The three-dimensional effects in turbo machinery, centrifugal machines, propellers, hydraulic turbines and wind turbines.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The working principles of turbines and pumps/compressors
II. The basic loading and performance analysis for a variety of machines
III. The fluid-thermodynamic mechanisms associated with performance degradation
IV. The basic operating principles of centrifugal machines, propellers, hydraulic turbines and wind turbines

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Relate the working principles of turbo machines for predicting its thermodynamic.
CO 2 Demonstrate typical designs of turbo machines and differentiate from positive displacement machines.
CO 3 Illustrate the off-design behavior of turbines and compressors and relate it to changes in the velocity triangles.
CO 4 Analyze the relations between choices made early in the turbo machinery design process and the final components and operability.
CO 5 Apply the Euler's equations for turbomachinery to analyze energy transfer in turbomachines
CO 6 Analyze the performance of turbo machinery by using the preliminary designs of pumps, compressors and turbines.

IV. COURSE CONTENT:

MODULE-I: ENERGY TRANSFER IN TURBO MACHINES (09)
Application of first and second laws of thermodynamics to turbo machines, moment of momentum equation and Euler turbine equation, principles of impulse and reaction machines, degree of reaction, energy equation for relative velocities, one dimensional analysis only.

MODULE-II: AXIAL FLOW COMPRESSORS AND FANS (09)
Introduction; Aero-Thermodynamics of flow through an Axial flow Compressor stage; Losses in axial flow compressor stage; Losses and Blade performance estimation; Secondary flows (3-D); Tip leakage flow and scrubbing; Simple three dimensional flow analysis; Radial Equilibrium Equation; Design of compressor blades; 2-D blade section design : Airfoil Data; Axial Flow Track Design; Axial compressor characteristics; Multi-staging of compressor characteristics; Transonic Compressors; Shock Structure Models in Transonic Blades; Transonic Compressor Characteristics; 3-D Blade shapes of Rotors and Stators; Instability in Axial Compressors; Loss of Pressure Rise; Loss of Stability Margin; Noise problem in Axial Compressors and Fans

MODULE-III: **AXIAL AND RADIAL FLOW TURBINES (09)**
Introduction; Turbine stage; Turbine Blade 2-D (cascade) analysis Work Done; Degree of Reaction; Losses and Efficiency; Flow Passage; Subsonic, transonic and supersonic turbines, Multi-staging of Turbine; Exit flow conditions; Turbine Cooling; Turbine Blade design - Turbine Profiles: Airfoil Data and Profile construction.

Radial Turbine: Introduction; Thermodynamics and Aerodynamics of radial turbines; Radial Turbine Characteristics; Losses and efficiency; Design of radial turbine.

MODULE-IV: ROTARY FANS, BLOWERS AND COMPRESSORS (09)
Classification based on pressure rise, centrifugal and axial flow machines; Centrifugal Blowers Vane shape, velocity triangle, degree of reactions, slip coefficient, size and speed of machine, vane shape and stresses, efficiency, characteristics, fan laws and characteristics; Centrifugal Compressor - Vector diagrams, work done, temp and pressure ratio, slip factor, work input factor, pressure coefficient, Dimensions of inlet eye, impeller and diffuser; Axial flow compressors; Vector diagrams, work done factor, temp and pressure ratio, degree of reaction, dimensional analysis, characteristics, surging, polytrophic and isentropic efficiencies.

MODULE-V: USE OF CFD FOR TURBOMACHINERY ANALYSIS AND DESIGN (09)
Computer aided blade profile generation, Cascade Analysis; Periodicity and boundary Conditions, 3-D blade generation and 3-D flow analysis, Flow track and inter-spool duct analysis and design

V. TEXT BOOKS:

1. Yahya S.H., Turbines, "Compressor and Fans", TMH, 2nd edition, 2008.
2. Venkanna B.K., "Fundamentals of Turbo Machines", PHI Learning Private Limited, 5th edition, 2005.
3. Nicholas Cumpsty, Compressor Aerodynamics, 2004, Kreiger Publications, USA.

VI. REFERENCE BOOKS:

1. Johnson I.A., Bullock R.O. NASA-SP-36, Axial Flow Compressors, 2002 (re-release), NTIS.
2. Kadambi V Manohar Prasad; "An Introduction to EC Turbo Machinery" Vol. III, Wiley Eastern, 1st edition, 1999.

VII. ELECTRONICS RESOURCES:

1. https://archive.nptel.ac.in/content/syllabus_pdf/101101058.pdf
2. http://www.slideshare.net/asifzhcet/fluid-mechanics-and-hydraulic-machines-dr-r-k-bansal

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.