



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Aeronautical Engineering

Subject Code: BE05001011

Subject Name: Fundamentals of Turbomachines

w.e.f. Academic Year:	2024-25
Semester:	5
Category of the Course:	Professional Core Course

Prerequisite:	Fundamentals of Aeronautical Engineering, Fundamentals of Fluid Mechanics, Thermodynamics for Aeronautical Engineering
Rationale:	Recent emphasis on energy problems has generated renewed interest in optimized design and performance of turbines and compressors, the main components of Aircraft jet engines. The course imparts fundamental understanding of flow physics, velocity and energy change across turbines and compressors and losses offered by them. The efficiency of each of them affects overall efficiency of aircraft engine and thrust developed.

Course Outcomes:

Sr. No.	CO statement	RBT Level
CO1	Understand to apply physics of flow through turbomachines like compressors, fans, blowers and turbine	Remember, Understand
CO2	Perceive basic terms and effect of flow on the turbomachines	Application, Remember, Understand
CO3	Interpret Matching and Performance Evaluation of the gas turbine engine components	Application, Evaluate
CO4	Analyze the performance and losses in turbines and compressors	Remember, Understand Application
CO5	Choose turbine and compressor rotor/ rotor blade for particular application in aviation and gas turbine plants	Remember, Understand Application

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
L	T	P	PBL	Total no of hours per semester		Theory		Tutorial / Practical			
						ESE (E)	PA / CA (M)	PA/CA (I)	TW/SL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

* *Problem-Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.*



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Content:

Module No.	Detailed Contents	Hours	% Weightage
1	Fundamentals of Turbomachines: Turbo machines, Turbines, Pumps and compressors, Fans and blowers, Incompressible and compressible flow machine, Stages of Axial, radial, mixed, reaction and impulse. Variable reaction stage, Multistage, Stage velocity triangle, Design and off-design conditions	4	10%
2	Axial Flow Compressor: Introduction, Geometry and working principle, Stage velocity triangles, H-S diagram, Flow through blade row, Stage losses and efficiency, Work done factor, Low hub-tip ratio, Supersonic and transonic stages, Performance characteristics	10	25%
3	Centrifugal flow compressors: Introduction and different parts of centrifugal compressor, Principles of operation, H-S diagram, Nature of impeller flow, Slip factor, Diffuser, Volute casing, Performance characteristics and losses in centrifugal compressor.	10	20%
4	Axial Turbine: Introduction, Stage velocity triangle, Single impulse stage, Multistage velocity compounded impulse and Multistage pressure compounded impulse, Reaction stages, Blade to gas speed ratio, Losses and efficiencies, Performance charts, Low hub-tip ratio stage, Turbine Blade Cooling techniques :- Internal cooling & External cooling	10	25%
5	Radial Turbine: Elements of radial turbine stage, Stage velocity triangles, H-S diagram, Stage losses, Outward flow radial stage and Performance characteristics	6	10%
6	Component Matching and Performance Evaluation: Introduction, Equilibrium running diagram, Determination and procedure to find equilibrium points, General matching procedure of jet engines	5	10%
Total		45 Hours	100%

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
25%	35%	25%	10%	5%	-



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Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

The syllabus of *Fundamentals of Turbomachines* directly contributes to

SDG 9	Builds foundational engineering knowledge for industrial systems and infrastructure development
SDG 7, SDG 13	Helps improve energy efficiency and reduce emissions in energy systems
SDG 9	Supports innovation and optimization of advanced engineering systems
SDG 7, SDG 13	Focus on efficiency improvement and minimizing energy loss → cleaner energy usage
SDG 7, SDG 9	Enables design of efficient and sustainable energy and industrial systems

Reference Books:

1. Compressors Turbines and Fans: S.M.Yahya, Tata-McGraw Hill Publishing Company Ltd, New Delhi
2. Gas Turbine, Ganesan, Tata-McGraw Hill Publishing Company Ltd, New Delhi
3. Gas turbine theory, Cohen & Rogers, Longman Green & Co. Ltd, Orient
4. Elements of Gas Turbine Propulsion, Mattingly
5. Gas turbine Theory, Longman Private Ltd Khajooria & Dubey
6. Mechanics and Thermodynamics of Propulsion, Philip G. Hill & Carl Peterson Addison Wesley: Longman, Inc
7. A Treatise on Turbo machines, Gopalakrishnan .G and Prithvi Raj .D, Scifech Publications
8. Hand book of Turbomachinery, Earl Logan, Jr. Marcel Dekker Inc., 1992

List of Experiments:

1. To Study the different types of turbomachines.
2. To study about performance parameters of turbomachines.
3. Performance test on Impulse turbine.
4. Performance test on Reaction turbine.
5. Performance test on centrifugal pump.
6. Performance test on axial flow fan.
7. Performance test on centrifugal blower.
8. Performance test on axial compressor stage.
9. To design compressor rotor blade.
10. To study losses occurred in turbo machines.



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List of Open Source Software/learning website:

<https://nptel.ac.in/>

List of suggested activities for Problem-based Learning (PBL):

Sr.No.	PBL Category	Name of the activity	No. of hours	Evaluation Criteria
1	Industry / Research Laboratory Visit	Industry/Research laboratory Visit (Power converters/electronics /drives company)	Visit = 5hrs, Report preparation = 5hrs Total = 10hrs	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2	Video Based Learning	Technical Video based learning related to the subject (MOOC/NPTEL Video)	Duration of video = 5hrs Report preparation = 5hrs Total = 10hrs	Report /presentation based on the video learning outcomes.
		Self-learning on-line course	Minimum duration of the course should be 10hrs.	Examination based assessment at the end of course. Based on the certificate produced.
		Annotated Video Explanation of Concept/Problem	10hrs (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
3	Assignment/ Technical Writing / Research Writing	Assignment writing. Numerical based assignment is preferable.	5 assignments of 2hrs each. Total = 10hrs	Based on the assignment submitted.
		Blog or Technical Article Writing	10hrs (Research – 6hrs, Writing – 4hrs)	Based on originality, technical content, references cited, and clarity of communication.
4	Complex Problem-Solving targeting	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 15 hrs	Based on the depth of the solution submitted.



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	relevant SDGs. / Mini Project			
5	Research Paper Review / Analysis	Discussion on research paper based on relevant subject (SCOPUS Index/any reputed Journal)	5 research paper = 20 hrs	Summarize research paper and evaluation critical parameters
6	Poster/ Chart/ Power point presentation	Poster/chart/power point preparation on technical topics	Duration = 6 hrs	Based on poster/chart preparation and presentation skills
7	Micro Project	Working/non-working model on technical topics	Working = 10hrs Non-working = 10hrs	Based on inter department/external evaluation
8	Group Discussion / Quiz / Simulation	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 hrs each	Based on performance in group discussion, technical depth, knowledge etc.
		Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10hrs	Based on quiz scores and reflection report after each quiz.
9	Case Study Analysis / Seminar	Real world case studies-based learning	Duration of data collection/study = 5hrs Report preparation = 5hrs Total = 10hrs	Based on in-depth study, technical depth, data collected, fact finding, etc.
10	Other	Patent Search and Innovation Gap Identification	10hrs (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject *Fundamentals of Turbomachines*;

- Mini Project – 10 Marks
- Seminar activities— 10 Marks

These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of



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PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.

2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.
