25UMET415	TURBOMACHINERY	Category	L	T	P	R	Credit	Year of Introduction
		PEC	3	0	0	0	3	2025

Preamble: This course introduces the application of fundamental principles of fluid mechanics and thermodynamics in the operation of turbomachines. It provides an understanding of radial and axial flow machines, focusing on the working principles and performance of power-generating and power-consuming turbomachines used in engineering practice.

Prerequisite: ICM104 Introduction to Mechanical Engineering & Civil Engineering

Course Outcomes: After the completion of the course, the student will be able to:

CO	Course Outcomes	Knowledge Level
CO1	Apply principles of fluid mechanics and thermodynamics to determine the efficiencies of turbomachines.	**K3 Apply**
CO2	Apply velocity triangle analysis to determine the performance of radial and axial flow turbomachines.	**K3 Apply**
CO3	Select an appropriate power generating turbomachine for a particular application.	**K3 Apply**
CO4	Select an appropriate power consuming turbomachine for a particular application	**K3 Apply**

Mapping of course outcomes with program outcomes and program specific outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	2	-	-	-	-	-	-	2	1
CO2	3	3	1	2	2	-	-	-	-	-	-	2	2
CO3	2	2	3	1	2	-	-	-	-	-	-	3	3
CO4	2	2	3	1	2	-	-	-	-	-	-	3	3
Avg	**2.5**	**1.75**	**2.33**	**1.33**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2.5**	**2.25**

Mapping of course outcomes with Knowledge and Attitude Profile (WK)

	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	*	*	*	*	*	*	-	-	-
CO2	*	*	*	*	*	*	*	-	-
CO3	*	*	*	*	*	*	*	*	-
CO4	*	*	*	*	*	*	*	*	*

WKs Mapped with the course

WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
*	*	*	*	*	*	*	*	*

Mark Distribution:

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	**40**	**60**	**2.5 hrs**

Continuous Internal Evaluation Pattern:

Attendance : 5 marks
Continuous Assessment Test : 20 marks
Continuous Assessment Assignment : 15 marks

SYLLABUS

Module 1 (10 hrs)

Introduction: Definition of turbo machine, Classification: Axial flow, radial flow and mixed flow machines, parts of turbo machines, Comparison with positive displacement machines. Applications in power plants, aerospace and process industries. Thermodynamics of fluid flow: Application of first and second law of thermodynamics to turbo machines. Preheat factor in compressors, work and efficiency for compressors and turbines. Energy exchange in Turbo machines: Euler's equation, Alternate form of Euler's equation, components of energy transfer. Specific speed and specific diameter. Dimensional analysis and similarity laws.

Module 2 (10 hrs)

General Analysis of Turbo machines: Radial flow compressors– general analysis, degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance. Slip factor and its significance. Losses in radial machines. Axial flow compressors-degree of reaction, velocity triangles. Free vortex and constant reaction designs. Performance characteristics and flow coefficients. Introduction to axial flow turbines.

Module 3 (10 hrs)

Hydraulic Turbines: Classification Pelton Wheel – Principle of working, velocity triangles,

efficiencies and losses. Reaction turbines – Francis turbine: Principle of working, velocity triangles, efficiencies and losses, draft tube, governing, cavitation. Kaplan and Propeller turbines - Principle of working, velocity triangles, efficiencies and losses. Selection of turbines for power plants. Modern hydraulic turbine materials and coatings. Pumped storage plants and reversible turbines. Environmental considerations in hydro power plants.
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Module 4 (12 hrs)

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Theoretical head – capacity relationship, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel. Performance curves and operating point. Fans, Blowers and Compressors: Classification and working principles of fans, blowers and compressors. Centrifugal Compressors: Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging and problems. Introduction to multistage compressors. Intercooling, reheating and regeneration concepts. Computational Fluid Dynamics (CFD) applications in turbomachinery. Energy efficiency and sustainability considerations

Text Books:

1. Dixon, S. I., *Fluid mechanics and thermodynamics of turbomachinery.* Pergamon Press, 1999.
2. Yahya, S. M., *Turbines, compressors and fans.* Tata McGraw Hill, 1996.
3. Venkanna, B. K., *Fundamentals of turbo machinery* (1st ed.). PHI Learning, 2009.

Reference Books:

1. Gambini, M., & Vellini, M., *Turbomachinery: Fundamentals, selection and preliminary design* (1st ed.). Springer, 2021.
2. Dick, E*., Fundamentals of turbomachines* (2nd ed.). Springer, 2022.

END SEMESTER EXAMINATION – MODEL QUESTION PAPER

Course Code	**25UMET415**
Course Name	**TURBOMACHINERY**
Max. Marks: 60	**Duration: 2.5 Hours**

Part A

(Answer all questions. Each question carries 3 marks)

Qn No.	**Question**	**Marks**	**CO**	**BL**
1	Illustrate the classification of turbomachines with appropriate examples after explaining their basic concept.	3	1	L3
2	Apply Euler's equation to explain the energy transfer process in turbomachines and discuss its practical significance.	3	1	L3
3	Apply the concept of degree of reaction to explain its importance in energy transfer within turbomachines.	3	2	L3

4	Illustrate the importance of the slip factor in the analysis and design of centrifugal compressors.	3	2	L3
5	Compare impulse and reaction turbines.	3	3	L3
6	Illustrate the phenomenon of cavitation in hydraulic turbines and discuss its effects on turbine performance	3	3	L3
7	Relate Net Positive Suction Head (NPSH) to the suction performance and cavitation characteristics of centrifugal pumps.	3	4	L3
8	Interpret the performance characteristics of fans, blowers, and compressors for suitable engineering applications	3	4	L3
Part B (*Answer any one full question from each Module. Each carry 9 marks*)				
Module I				
Qn No.	**Question**	**Marks**	**CO**	**BL**
9.a)	Interpret the classification of turbomachines and explain their suitability for power generation, aerospace, and process industries.	5	CO 1	L3
9.b)	Apply Euler's equation to explain the energy transfer mechanism in turbomachines.	4	CO 1	L3
OR				
10.a)	Relate the first and second laws of thermodynamics to the performance of turbomachines.	5	CO 1	L3
10.b)	Determine the significance of specific speed and specific diameter in turbomachine selection using similarity principles.	4	CO 1	L3
Module II				
Qn No.	**Question**	**Marks**	**CO**	**BL**
11.a)	Construct the velocity triangles for a centrifugal compressor and determine the work done using Euler's equation.	5	CO 2	L3
11.b)	Apply the principles of centrifugal compression to evaluate the influence of slip factor and blade outlet angle on compressor performance.	4	CO2	L3
OR				
12.a)	Construct the velocity triangles for an axial flow compressor and determine the degree of reaction.	5	CO 2	L3
12.b)	Illustrate the design concepts of free vortex and constant reaction and discuss their significance in axial flow compressors.	4	CO2	L3
Module III				
Qn No.	**Question**	**Marks**	**CO**	**BL**

13. a	Select a suitable hydraulic turbine for a given head and discharge condition by comparing the characteristics of Pelton, Francis and Kaplan turbines.	5	CO 3	L3
13. b	Apply the concepts of the draft tube and governing system to interpret their roles in the operation of reaction turbines.	4	CO 3	L3
OR				
14. a	Apply velocity triangle concepts to explain the working of a Pelton wheel and determine its hydraulic efficiency.	5	CO 3	L3
14. b	Relate the phenomenon of cavitation to turbine performance and suggest appropriate methods for its prevention.	4	CO 3	L3
Module IV				
Qn No.	**Question**	**Marks**	**CO**	**BL**
15. a	Illustrate the construction and working of a centrifugal pump and interpret its performance characteristics	6	4	L3
15. b	Select a suitable pumping arrangement by comparing pumps connected in series and parallel for different engineering applications.	3	4	L3
OR				
16. a	Apply the working principles of centrifugal compressors to interpret the phenomena of surging and choking, and recommend suitable methods to improve performance.	6	4	L3
16. b	Select an appropriate power-consuming machine (fan, blower or compressor) for a given industrial application with justification.	3	4	L3

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