

TEE-908 Advance Turbomachinery Applications

1. Course Objectives

- a. To develop fundamental understanding of various turbomachinery systems and their applications.
- b. To understand the theoretical concepts and practical aspects of turbomachinery design and development process.
- c. To train the researchers for advance level of turbomachinery design and development involving computational and experimental methods.
- d. To identify modern energy conversion systems advantageous for Pakistan's energy sector.
- e. Generate scientific knowledge and expertise in the field of turbomachinery.

Course Contents

6. Contents with suggested contact hours

No.	Topics	Contact Hours
a.	Overview of Turbomachinery <ul style="list-style-type: none">• Governing laws• Euler turbomachinery equation• Incompressible and compressible flow relations• Compressor and turbine efficiencies• Irreversibility and losses• Velocity diagram and work transfer• Dimensional performance of turbomachinery• Design and off-design performance characteristics	6
b.	Compressor Aero-Thermodynamics <ul style="list-style-type: none">• Introduction to compressors• Axial flow compressors• Radial flow compressors• Stall and surge phenomena in	6

	<p>compressors</p> <ul style="list-style-type: none"> • Mean-line and three-dimensional design • Mechanical design features 	
c.	<p>Turbine Aero-Thermodynamics</p> <ul style="list-style-type: none"> • Introduction to turbines • Axial flow turbines • Radial flow turbines • Turbine blade cooling • Mean-line and three-dimensional design • Mechanical design features 	6
d.	<p>Gas Turbine Application</p> <ul style="list-style-type: none"> • Gas turbine cycles • Industrial gas turbine design and features • Propulsion gas turbine design and features • Design and off-design performance • Support systems, combustion, transmission • Recent developments and challenges 	5
e.	<p>Automotive Application</p> <ul style="list-style-type: none"> • Introduction to IC engines • Turbocharging methods for IC engines • Turbocharger system and components • IC Engine-Turbocharger matching • Recent developments and challenges 	5
f.	<p>Wind Energy Application</p> <ul style="list-style-type: none"> • Introduction to Wind Energy • Wind turbine design and components 	3

	<ul style="list-style-type: none"> • Actuator disk and blade element theories • Environmental matters • Recent developments and challenges 	
g.	Hydropower Application <ul style="list-style-type: none"> • Hydroelectric, tidal, ocean, wave power • Hydraulic turbines – Pelton, Francis, Kaplan • Design and performance • Recent developments and challenges 	3
h.	Small-Scale Turbomachinery Application <ul style="list-style-type: none"> • Microturbine technology • Heat pump turbocompressor technology • Organic Rankine cycle (ORC) turbogenerator technology • Recent developments and challenges 	3
i.	Computational Fluid Dynamic (CFD) Practices for Turbomachinery Design <ul style="list-style-type: none"> • Introduction to CFD for turbomachinery • Steady and unsteady CFD applications • Design optimization and CFD • Recent developments and challenges 	4
j.	Experimental Techniques for Turbomachinery <ul style="list-style-type: none"> • Experimental facility features • Instrumentation, calibration, accuracy, and uncertainty 	4

	<ul style="list-style-type: none"> • Data collection and processing • Recent developments and challenges 	
	Total	45

Outcomes

3. By the end of this course students will be able to:
 - a. Perform design and development activities for different energy conversion systems.
 - b. Familiarize with modern developments in the field of turbomachinery.

4. **Recommended Reading (including Textbooks and Reference books).**

S. No.	Title	Author(s)	Remarks
a.	Fluid Mechanics and Thermodynamics of Turbomachinery	S.L. Dixon	Text Book
b.	Gas Turbine Theory	H.I.H. Saravanamutto, G.F.C. Rogers, H. Cohen	Reference Book
c.	Alternative Energy Sources	E.E. Michaelides	Reference Book
d.	Internal Combustion Engine Fundamentals	J.B. Heywood	Reference Book
e.	Turbocharging the Internal Combustion Engine	N. Watson, M.S., Janota	Reference Book
f.	Fundamentals of Turbocharging	N.C. Baines	Reference Book
g.	Wind Power Plants	R. Gasch, J. Twele	Reference Book

h.	Solar Energy Engineering	S. A. Kalogirou	Reference Book
i.	Microturbines	C. Soares	Reference Book
j.	An Introduction to Computational Fluid Dynamics	H.K. Versteeg, W. Malalasekera	Reference Book
k.	Advanced Experimental Techniques in Turbomachinery	D. Japikse	Reference Book
l.	Measurement Techniques in Fluid Dynamics	J. Anthoine, T. Arts, R.A. van den Braembussche	Reference Book
m.	Elements of Propulsion	J.D. Mattingly	Reference Book
n.	Unsteady Computational Fluid Dynamics in Aeronautics	P.G. Tucker	Reference Book

5. Recommended journals:

- a. Journal of Turbomachinery
- b. Journal of Engineering for Gas Turbines and Power
- c. Journal of Applied Energy